AGRICULTURAL ENGINEERING

Published monthly by the American Society of Agricultural Engineers
Publication Office, Bridgman, Michigan. Editorial and Advertising Departments at the Headquarters of the Society, Saint Joseph, Michigan

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to members of the Society, $2.00 a year. Postage to countries to which second-class rates do not apply, $1.00 additional. Entered as second-class matter, October 8, 1925, at the post office at Bridgman, Mich., under the Act of August 24, 1912. Additional entry at St. Joseph, Mich. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title AGRICULTURAL ENGINEERING is registered in the U. S. Patent Office.

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Advertising Representatives: J. C. Billingslea, Inc., 123 W. Madison St., Chicago; Knox, Inc., 101 Park Ave., New York.

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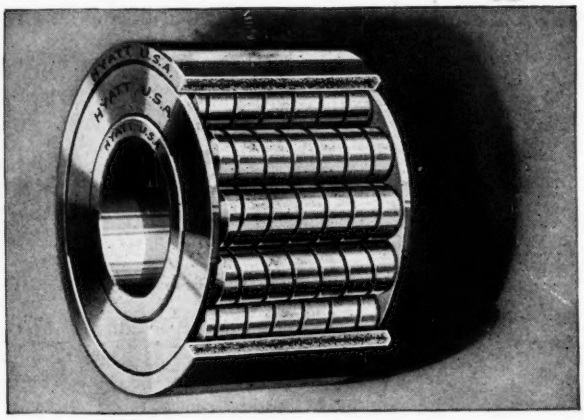

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AGRICULTURAL ENGINEERING

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Results of a Corn Harvesting Machinery Experiment

By R. L. Patty[1] and D. E. Wiant[2]

"A ONE-ROW corn picker-husker will harvest an average of 205 bushels of corn per day. It takes an average of 2½ men and 5½ horses, or a tractor, to do this, besides the teams for hauling." This quotation is from a report made in 1926 by the U. S. Department of Agriculture (agricultural economics and agricultural engineering cooperating) after a survey of picker-husker operators through eastern South Dakota. One of the authors (Patty) was raised in South Central Iowa where a man must pick 100 bushels of corn a day by hand, to be considered worthy of his meals, so when he read the foregoing figures (205 bushels per day average) for a machine picker and requiring 2½ men, he decided that more speed would be necessary in corn harvesting, for strict efficiency, and decided this was one of the projects he wanted to get under way in the agricultural engineering department of the South Dakota State College at Brookings.

The first step taken was to solicit the manufacturers of one-row picker-huskers to see if they were working on and were expecting to put into production a two-row picker-husker. Being assured that they were not, it was decided to work on the idea of snapping two rows of corn at a time and husk it at the crib as it was being elevated. The machines were put into operation this past fall on the farm of J. W. Wilson, director of the South Dakota Agricultural Experiment Station, and about 30 acres of corn were harvested.

Being interested only in the improvement of machinery, publicity was given the idea from the start. Feeling sure that some manufacturer would develop a two-row corn snapper sooner or later, the department set to work on the husker-elevator machine which was to be used at the crib.

After a winter spent in the study of husking rolls, their optimum speed, length, diameter, angle, and husking pegs, the work on the machine began. It was set up and operated this fall and proved quite satisfactory, although some changes will be made in it for next season. The husker is a compact machine that fits into any portable farm elevator and husks the corn as it is being elevated into the crib. It weighs 2010 pounds and its dimensions without the blower are 10 feet by 5 feet 8 inches, by 6 feet 4 inches high.

The husks are blown into a picket crib or any desired place where they can be used for feed and bedding. This was one of the advantages considered in favor of this method of harvesting, the fact that the husks are saved instead of being blown into the fence row. They seem to have considerable worth as feed and bedding today, and may have a greater future value commercially. They can be very easily baled. The bales of husks weigh 60 pounds and the husks handle very nicely for baling.

An interesting figure on the relative weights of husks to corn for central South Dakota has been arrived at in this study. The figure is 9 per cent; that is, 9 pounds out of every 100 pounds of snapped corn is husks.

Other advantages that were considered favorable for this method of harvesting are the saving of power required to carry the heavy husking bed back and forth across the field, the increased speed of harvesting, and the saving of all the shelled corn from the husking rolls. At the time this study was started it was thought that a two-row picker-husker would require too much power to be successful. This has not proven true since it has come onto the market. Its success in this respect is due to two things: (1) The use of structural steel in place of heavy iron castings, which makes it possible to build a two-row picker-husker which weighs but very little more than the former one-row picker-husker, and (2) the use of the power take-off. (The J. I. Case Company was the first to put a two-row snapping machine on the market. One of their machines was used in field tests with the husker-elevator this fall. Perhaps it should not be called a "snap-

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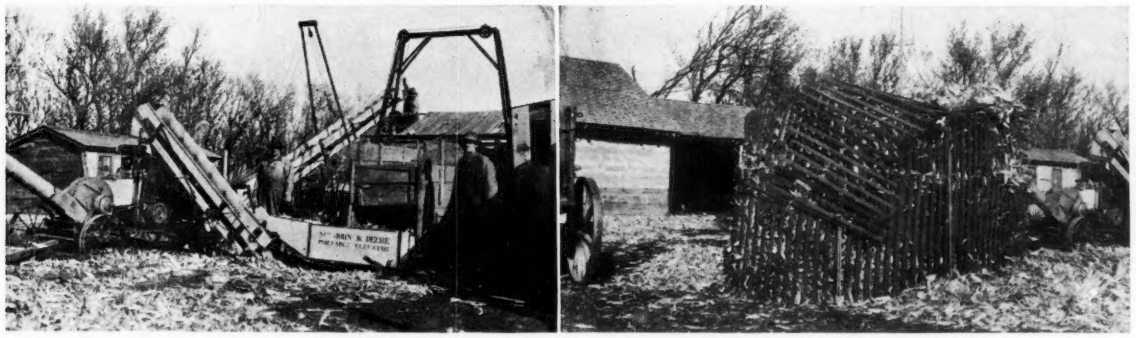

(Left) The husker-elevator in action. (Right) The picket crib in which husks from the husker-elevator were stored. Saving of the husks is an advantage in this method of harvesting corn. One difficulty experienced was the blowing of the husks as indicated in the picture. An extra panel of slats was thrown over the top as shown, and the problem was pretty well solved

per" as it husked quite a high percentage of the ears, especially when there was sufficient moisture on the corn. At any rate it proved to be a satisfactory light-running machine.)

Even though the two-row picker-husker has solved part of the problem of efficiency by increasing the speed of harvesting, the two-row snapper and husker-elevator combination can harvest corn considerably faster yet than the two-row picker-husker. This was easily demonstrated this past fall when the machines harvested 13 acres of corn in 4 hours and 15 minutes on an afternoon demonstration run, the crowd watching the demonstration interfering with the speed somewhat. This was harvesting at a rate of 30 acres of corn per 10-hour day. And owing to a light yield in the field being harvested, the husker-elevator was standing idle two-thirds of the time. The two-row snapping machine shown in one of the accompanying pictures travelled at a rate of 3.72 miles per hour. The tractor handled the machine in second gear, snapped the two-rows of corn and pulled the loaded wagon easily. Since the corn was yielding less than 20 bushels per acre, it did not keep the husker very busy. A rough check on corn losses in the field showed practically no greater loss of corn at second speed than when the machine was pulled in low gear.

The yield of corn this past fall was not enough to keep the husker running for an hour at a time, but several loads were timed as they were being unloaded. The average time required to actually unload and husk a 40-bushel load of snapped corn (by measure, a bushel to the inch in the wagon bed) was 10 minutes and 55 seconds. At this rate the husker would handle 220 bushels of snapped corn in one hour of continuous operation. But allowing four minutes for driving the empty wagon out and the loaded wagon in, and the usual amount of "time out" for care of the machine, an estimate of 160 bushels of snapped corn per hour would seem about right for the capacity of this machine. Eight rolls of about average length were used in the husking bed. The angle of the rolls was 20 degrees with the horizontal and the speed of the rolls was 304 revolutions per minute.

CLEANNESS OF HUSKING

The stationary husker did cleaner husking than the field machines with which it was compared this fall. This may have been due to the slightly higher speed of the husking rolls, or to the device used for straightening the ears as they were fed onto the husking rolls, or it might have been partially due to the lack of pitching of the machine. Several loads of corn that had been harvested with a picker-husker, owned by the renter on Director Wilson's farm, were brought over and run through the stationary husker for a second, and cleaner, job of husking.

None of the field machine husking in eastern South Dakota was as clean this past fall as usual. This was due to the fact that the corn was very dry. The weather was dry during the early part of the corn husking season and the nights were singularly free from dew or frost. No actual tests were made of the cleanness of husking for the stationary husker but the results were excellent.

In designing the husker-elevator machine its function was to take the snapped corn as it is dumped from the wagon, elevate it into the husking rolls, elevate the husked corn to the crib, after separating out the shelled corn, and carry the husks to the storage provided. To be a success, such a machine must have plenty of capacity, must do a clean job of husking, must keep the percentage of shelled corn at a minimum, and dispose of the husks in a satisfactory manner.

In designing this machine the idea was to build it as simple as possible. The attempt to combine the elevator and husker as one unit was abandoned in favor of making the husker a separate unit in order to keep the husker compact and to leave the elevator readily available for handling grain other than corn. In fact, any portable farm elevator can be used with this machine by having one extra short section of 12 feet.

The Case two-row corn snapper used with the husker-elevator in the South Dakota experiment. This machine snapped 13 acres of corn in 4 hours and 15 minutes and husked a good percentage of the corn. The machine and wagon were pulled by the tractor at the rate of 3.72 miles per hour.

A start was made to build a new large husking bed of somewhat original design, but lack of time made it necessary to use a bed that was already assembled. A John Deere eight-roll husking bed was available, and it was used. The rolls checked fairly well with the optimum roll which had been determined in the research laboratory. The husking rolls were installed at an angle of 20 degrees with the horizontal and were driven at a speed of 304 rpm. A 26-inch blower fan was used on the machine for handling the husks. It was off the U. S. Goodhue shredder and is driven at 1200 rpm. The device made for straightening the ears and forcing them onto the husking rolls was a result of laboratory tests with various types of retarders and agitator equipment.

All of this equipment was mounted on an "Electric Wheel" steel truck. For although the machine is referred to as a stationary husker, it is readily portable from one job to another. A sheet steel connection was built from the husk conveyor to the blower and the blower pipe was built of the same material.

The main driveshaft was mounted on ball bearings. It was equipped with a 14-inch Rockwood pulley and is driven at 1000 rpm. By means of steel sprockets and a roller chain a counter shaft with a bevel gear at one end and supported on roller bearings was driven at 250 rpm. The husking roll driveshaft was driven from this shaft, and also the husked corn elevator. The feed elevator and wagon dump were driven from the bevel gear shaft through a clutch on the feeder elevator. All drives were chain drives with the exception of the blower and the ear agitator. The feeder elevator was supported by a frame bolted to the truck frame and the outer or lower end was fastened rigidly by means of an A-shaped brace.

The capacity of the machine was not great enough at the first trial run, and there is some question whether it is large enough yet, but it was greatly increased. This was done by means of an agitator operated by a cam to force the ears onto the husking bed faster; and also by another device for straightening the ears on the husking bed.

No serious difficulties were encountered during the harvesting period. A very few forced stops were made. The faults of the husker were noted and will be remedied. A little extra attention was given to the blower until the pipes were smooth. The blower pipe plugged up once, due possibly to the presence of a great amount of stalks in the corn that was snapped when it was very dry. If a flexible elbow does not remedy the situation, a larger pipe will be installed. These dry stalks also hindered

Table I. Effect of Different Angles of Rolls on Capacity, Quality of Husking, and Shelling
(Figures are relative, averages)

Angle of rolls, degrees	Capacity	Quality	Shelling
10	0.17	97.9	4.4
15	0.38	94.1	3.9
20	0.65*	96.2**	4.4**
25	0.62	82.6	3.0

*Belt agitator only.
**Belt agitator and double retarders.

Table II. Effect of Speed of Rolls on Capacity, Quality of Husking, and Shelling
(Relative figures, averages)

Speed of rolls, rpm.	Capacity	Quality	Shelling
150	0.30	92.0	2.6
200	0.43	90.8	3.8
300	0.61	89.3	3.9
400	0.50*	94.4*	3.6*

*Agitator used.

the feeding, but next year the agitator will be lengthened and the number of strokes increased.

When the stalks hindered the feeding, or the vibrating bottom was held up from the vibrator cam by a stray ear of corn, the hopper would fill up to the discharge of the feeder elevator and an occasional ear would be carried down the return and wedge under a conveyor slat. A little more clearance can be gained by increasing the angle of the feeder elevator. The vibrating bottom will be raised slightly to give room enough to clear any stray ears.

We found it somewhat difficult to confine the husks in a slat crib especially during an unusually windy day. This was finally accomplished by using two sections of crib, one above the other, and throwing another section across the top.

HUSKING ROLLS

From a study of the arrangement and design of husking rolls from fifteen corn husker-shredders, we found that the conformation of the surface of a husking roll may vary from a perfectly smooth-surfaced roll with a spiral groove to a roll resembling an elongated spur gear; that the diameter varies from 2½ to 4 inches and the length from 36 to 65 inches. Practically all husking rolls are equipped with pegs, with a short peg for a roll of large diameter and a longer peg for a roll of small diameter. In various husking machines there is a difference in the angle at which the rolls lie, varying from 10 to 18 degrees with the horizontal. The rolls of one machine were installed at a 25-degree angle. While the length of the roll is somewhat associated with the capacity, the angle at which the roll is set gives a closer relationship. In practically all cases the shorter rolls are placed at a lesser angle with the horizontal than the longer rolls. Therefore, the capacity of any type of roll is determined by the diameter of the roll, length of roll, speed, and the angle at which they are placed. It can readily be seen that the true dimension of a husking roll in motion is: Length x perimeter x rpm.

Three sets of rolls were used in actual laboratory tests, which we conducted, each set being chosen as a representative of a particular group of husker-shredder rolls.

The tests run on each set of rolls consisted of a series of trials to determine (1) at what speed of rolls the greatest capacity can be obtained with a maximum efficiency of husking and the minimum of shelling; (2) what diameter and length of roll is most desirable; (3) what type of husking peg is most efficient, and (4) what type, how many, and where the ear retarder or retarders should be placed.

We will not undertake to give the results of these tests in detail in this paper but will include two simple and typical tables, on one set of rolls tested, showing the effect of speed of rolls (Table I) and the effect of the angle of rolls (Table II).

To sum up briefly the results of the tests on the rolls we arrived at the following conclusions:

1. A roll speed of between 250 and 300 rpm. is most desirable.
2. Speed seems to have more effect upon the capacity than any other factor.
3. An angle of 18 to 20 degrees gives the best results for a stationary husker.
4. A husker roll 36 inches long is long enough for practical purposes.
5. Rolls with a small diameter husk the smaller ears better than do the rolls of greater diameter, while the larger rolls are more efficient with the larger ears.
6. A retarder above the rolls is necessary if an efficient job of husking is to be done.
7. The feeder belt type gives the highest capacity and should be run at possibly 50 to 60 feet per minute.
8. Smooth-surfaced rolls with plenty of pegs, husk just as clean and shell less corn than rough rolls.
9. A short peg with a sharp edge, such as a screw head, does the most efficient job of husking with the least amount of shelling.

(AUTHORS' NOTE: The study is not yet finally completed and the right to change some of the above observations is reserved.)

Husking ear corn as it is being elevated. This machine was built in the agricultural engineering department of the South Dakota State College. The wagon being unloaded is directly back of the machine. The husks are being blown into the picket crib directly behind the tractor, and in the bags shown in the foreground is the shelled corn that was saved. This machine husked and elevated corn at the rate of 160 bushels per hour this past fall. It is still in the experimental stage

The Economics of Farm Structures[1]

By J. L. Strahan[2]

TO OUTLINE a plan for conducting research in farm building economics is much more than a one-man job. To find a way for determining just what is the value of farm buildings in terms of returns on the investment in them is going to require the cooperation of economists, farm management specialists and persons trained in statistical methods.

But regardless of who does the work, it is evident at the start that the information we will need will be found on the farms. Possibly some of it has already been collected and is hidden away in farm management survey reports. From the farms and from such reports, it must be collected and brought together for study and analysis.

The process of bringing it together calls for machinery that can probably best be developed by the trial-and-error method. H. B. White[3] first, and more recently J. C. Wooley[4], and others have had experience in gathering data that will be of invaluable assistance in working out standard methods of procedure.

The collection and analysis of data concerning present conditions will show us what are now the building practices of farmers in general, and of dairymen, poultrymen, fruit growers, grain farmers, cotton growers, etc., in particular. It will tell us how much money has been invested in placing these practices in operation. In other words, it will present the situation as it now exists. This, of course, is not the ultimate aim of structures research. But it is a very necessary first step in approaching the problem either from an economic or a strictly engineering standpoint. For when we know what is, we will be in a position to study the relative value of something different.

The field of agriculture is wide. It embraces numerous businesses, each of which has building problems peculiar to itself. Buildings suitable for one type of farming are not likely to be best adapted to another; they may not even be economically convertible. The relation between building costs and other production cost factors might be quite different in different agricultural businesses. Therefore, it will undoubtedly be found expedient to study these relations in one type of business at a time. But regardless of these differences, there is one basic idea that is common to all. This is the idea that money spent for farm buildings must be considered in the light of an investment and not as a necessary evil to be pared down to the very lowest possible point regardless of the actual necessities. As this idea comes more and more to influence our work and thought in this field, more and more will the actual money value of adequate design become apparent.

Not long ago I made a study of the relation between building costs and other costs involved in whole milk production. I remember using $30 per year as the rental value of barns per cow, and showing how this much money could be returned by a good cow over and above all other costs. But this was construed by some to mean that I was definitely advocating the expenditure of $300 per cow for stable construction. As a matter of fact, I wasn't, nor do I now. The figures I assembled for costs other than buildings were those found to represent conditions as they actually existed at the time the various surveys were made. The figures I used in the same chart to represent the building costs were hypothetical. If the actual facts concerning building costs as they are had been used, the picture would have been somewhat different. The total cost of production would have been less, because $300 is much higher than the present average per cow investment in dairy stables throughout the country.

My object was to emphasize the possibilities for good cows paying for good buildings, and poor ones not paying for any. I pointed out that no one could yet say just what the net effect of increasing the building investment would be on total cost nor conversely, what the effect of decreasing it would be. It is quite conceivable, for instance, that increasing the investment in a barn by the cost of insulation and a ventilating system would affect feed costs, milk production, and herd depreciation to the extent that very good returns could be realized on the added investment. This has not yet been shown by actual figures, but many people, including myself, honestly believe it to be true. What we need to know is, not how can the costs of buildings be reduced, but what investment is permissible in the light of actual returns. We have no more right to assume that present costs are too high than to assume they are too low. But once we know what investment is permissible, we don't care what the first cost is. It becomes of importance only as the local banker is able to see the picture in its true light, and advances the necessary capital to make the investment.

Recent publications indicate clearly that this investment idea is not universally held, at the present time. Still some cling to the notion that low first cost is the prime consideration. I have recently reviewed a number of bulletins that reflect this general conception to such a marked degree as to indicate a real stumbling block to the prosecution of a research program that will involve the cooperation of all of the groups of interests concerned. It is with some hesitation that I attempt a discussion of this situation, but I feel that until this cost bugaboo and other misconceptions are cleared up, real progress is going to be difficult, particularly in the field of building economics.

THE INTERESTS INVOLVED

As outlined in a letter sent by the chairman to the members of the Structures Division of this Society in the fall of 1928, there are three principal groups involved in the farm building situation. First and foremost, there are the farmers, the agricultural industry. Second, there are the individuals and organizations engaged in the sale and fabrication of building materials and the manufacturers of building equipment. Last, but by no means least, there are the institutions of research, extension and teaching, to which both of the former groups should look for disinterested advice and counsel.

In the general scheme of things, the farmer's job is to produce. He is in a very real sense a manufacturer of agricultural products. He is no longer a jack-of-all-trades. It is the job of the manufacturers to produce the tools needed for agricultural production. It is the job of the public institutions to advise the manufacturers what tools to make and what their use requirements are to be. It is not their job to advise how to make them, because this is a design job that involves methods and costs peculiar to the individual manufacturer's plant and organization. On the other hand, it is the job of the institutions to advise the farmers how to use the tools to the best advantage. This position held by the institutions is one of immense potentialities for good as intermediaries between agriculture and industry. But not in the sense of being a buffer. Farmers do not need

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[1]Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers, at Chicago, December, 1930.

[2]Agricultural engineer, Louden Machinery Company.

[3]Division of agricultural engineering, University of Minnesota.

[4]Head, department of agricultural engineering, University of Missouri.

protection against industry. On the contrary, they very much need the services of industry.

I wish to point out a few self-evident facts that will very largely state the position of the manufacturers.

First, the equipment industry, and the materials industry so far as it operates in the agricultural field, exists, and will continue to exist, only as a result of a definite and natural demand for its products. The demand has grown out of a real need. It was not manufactured unnaturally. It is necessary only to glance through the catalogs of four or five of the larger concerns and to observe that the equipment described in them all is essentially the same so far as the major items are concerned to realize that the demand could not have been unnaturally inspired. These items are essentially the same because they are all designed to meet the same demand.

Second, if this demand is to be met, then the products of industry must be sold at a price that will insure the continuance of the business, namely, at a reasonable profit. If an article can be made only at a price that the consumer is unwilling or unable to pay, then that item is not long for this world. I think Charles Darwin covered that situation very comprehensively some 60 or 70 years ago.

Third, competition within any industry today is so keen as to make exorbitant profits an utter impossibility. I am violating no confidence nor am I divulging any trade secrets when I say that there are very few equipment concerns operating in the field today that pay as large returns on the invested capital as the average return throughout industry as a whole. This is no get-rich-quick opportunity for even the cleverest buccaneering captain of industry.

Now the fact is that many people who are not informed concerning the many cost factors involved in industrial production honestly think that consumer prices are much too high. And being honest in their convictions, they do not hesitate to voice them. No one of us, least of all myself, would deny any one a personal opinion, nor the right to express it. But when a person is in a position of authority, and his opinion carrries weight, he should be thoroughly informed on matters he discusses in his official capacity—he should know whereof he speaks. In the field of natural sciences a research worker's reputation, in fact the strict code of his scientific philosophy, restrains him from announcing any results that have not been checked and double-checked. But somehow or other, when he enters the less restricted field of economics, this restraint is relaxed; he is likely to express as definite conclusions ideas that are highly conjectural and in some cases at least quite beyond substantiation. It is my belief that when opinions are thus expressed in the absence of adequate data, they react harmfully against the very ones they were expected to help, in exact proportion as they vary from actual fact or truth. Let me be specific.

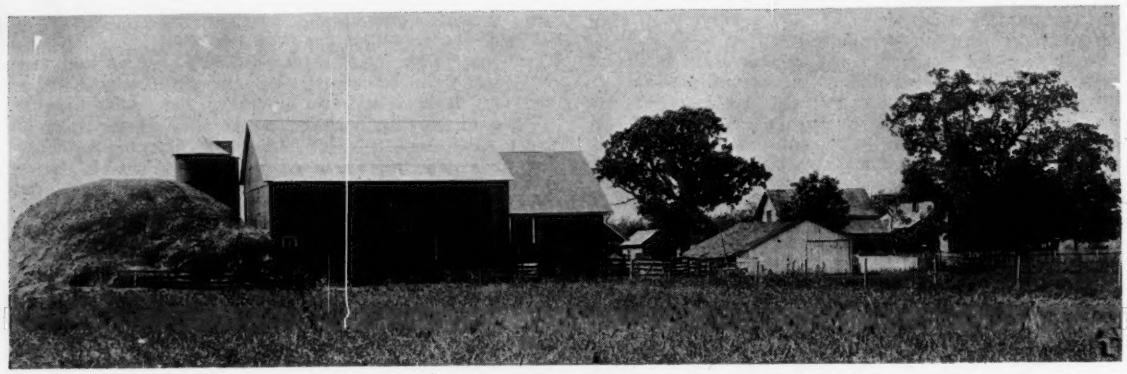
I have recently reviewed several publications from different institutions dealing either directly or indirectly with farm structures. One is a report of economic studies of the poultry industry in California, published in mimeographed form by the extension service of the University of California, cooperating with the San Bernardino County Farm Bureau. Another is Bulletin No. 118 from the University of Nevada, entitled "Efficiency in Dairying." A third is Bulletin No. 478 from Cornell University, entitled "An Economic Study of Farm Buildings in New York." These three are typical as indicating several phases of an attitude toward the structures problem held, I think quite unconsciously, by some of the institutions at the present time.

The first of these indicates a lack of conception of the relation between building design and production costs that is quite understandable in the light of the present research situation, and reflects no more discredit on the writer than failure to recognize the value of an internal-combustion engine would have discredited the prehistoric inventor of the wheel as an aid to transportation. To him, there simply isn't any such thing. He lumps building costs in with "miscellaneous overhead," and calls it a day.

The Nevada bulletin indicates a thoughtlessness in generalizing from insufficient data. For instance, a survey of Nevada dairy farms shows a very low investment in buildings per cow. A rough correlation between investment per cow and gross receipts indicates that when more than $50 per cow is invested, receipts are about $21 more than when the investment is $16 per cow. In a twenty-cow herd this would amount to $420 per year, interest on a building investment of $7000, or $350 per cow. I, of course, realize that this increased income is probably due to a number of factors besides buildings and should not, therefore, all be considered as applicable to such an overhead investment, but I surely think it indicates a larger profitable building investment than $25 per animal. That is the amount mentioned in this bulletin as required to provide what is termed "suitable shelter."

In other words, it sets the profitable building investment for a twenty-cow herd at only $500, an amount of money hardly sufficient to build an adequate one-car garage, let alone a stable for housing twenty cows. Either

Good buildings and equipment are a profitable investment when used in combination with high-production animals. Data are needed to establish this economic relationship between investment and farm profit on a more definite basis



There is one idea in connection with farm buildings that is of basic importance, namely, that money spent for them must be considered in the light of an investment, and not as a necessary evil to be pared down to the very lowest possible point regardless of the actual necessities

building costs are exceptionally low in Nevada, or else the term "suitable shelter" for dairy cows is not being used in the usual sense. And yet the same author says "for every dairyman has experienced the marked effect of cold winds and storms in decreasing the production of his dairy herd," undoubtedly himself recognizing the value of adequate environmental control. Again he computes the saving of labor cost by the use of a milking machine for a twenty-five cow herd as being $350 annually, on the next page stating that $25 per cow is the probable maximum profitable building investment. This would call for $625 to house the 25 cows. How can you put twenty-five cows and a milking machine in a stable that costs not more than $625 to build? I wish I knew the formula! I would also like to know why this saving in labor cost alone does not justify buildings and equipment that will make it possible.

The third reference, Cornell Bulletin No. 478, was written from data obtained by a survey of conditions that exist today, or at least did exist only two or three years ago in New York state. Yet it perpetuates in print economic ideas that seem to me should be as extinct as the dodo, ideas that undoubtedly had their inception in pioneer days when the farmer had no cash and had to be a jack-of-all-trades, just as his wife had to make candles, spin and weave the cloth from which she later fashioned the family's clothes; ideas that seem to have carried over into the modern era through sheer momentum and unchecked by careful scientific consideration. For instance, the author refers to "fancy" equipment, "rich men's stables," "commercial extras," etc., inferring that anything that is bought is somehow quite unattainable to the "average dairyman," whoever that may be, and indeed is probably inferior, anyway, to the sturdy farm-built equipment that can be had for practically nothing, and that will last a life time. At the risk of seeming hypercritical, I want to illustrate the point by a definite quotation.

On page 58, the author gives a list of stable equipment offered for sale to a farmer having thirty cows that was to cost $1136.63, or $37.89 per cow. The unit cost figure is mine. It did not appear in the bulletin. He states that as a result of an interview (presumably with him) this list was reduced by a total of $250, or $8.33 per cow. He adds that many other parts could have been omitted. How many, or which items, he leaves entirely to the imagination. Now this farmer was asked originally, I expect by some equipment salesman, to make an investment in equipment that would have required each cow to pay a yearly rental of $3.79 in addition to other cost items. The author of Bulletin No. 478 asked him to reduce this to a point where the rental charge would have been $2.96, or an annual saving of 83 cents per cow. But in the bulletin he offered no arguments whatever to show that labor or feed costs might not have been increased more than enough to offset this saving through failure to use the deleted items of equipment. In fact, it is very problematical if he could, or can. Furthermore, he precluded any possibility of debating the point by failing to state which items of equipment were omitted and why. He merely stated in so many words that the expense was unwarranted, and let it go at that.

The author in other references states that farmers are frequently oversold by concerns who make a practice of producing plans for barns; that the plans are drawn with the idea of installing the "maximum amount of expensive equipment." I suppose this occasionally happens when some one becomes particularly enthused over the possibility of a large sale. It is hardly fair, however, to judge the entire industry by the faults of a few individuals; no more fair than to judge the entire institutional personnel by the reduction and absurdum ideas sponsored by a few individuals.

I could continue almost indefinitely to discuss this Bulletin No. 478, but it would consume too much time and perhaps serve no good purpose. I have gone this far simply to call attention to a glaring example of the sort of idea that may tend to disrupt real cooperative effort to get to the truth concerning the economic status of farm buildings. Please understand that in doing so, I hold no special brief for the industries involved. I have no doubt that too much money is occasionally spent on barns at the instigation of men who have something to sell. But I also know that quite as often, perhaps even more so, too little is spent. Even the most rabid cost cutter of them all will admit, I think, that some cost in buildings must be allowed. Farmers quite definitely cannot get along with zero costs. And, on the other hand, even the most extreme advocate of "fancy" construction will recognize that there is a limit beyond which it is absurd to go in spending money for farm construction. Very well, the low limit is something more than nothing and the high limit is easily recognized by all. Somewhere between these two extremes is a level of expenditure that is rational and reasonable. It is the job of the research agencies to determine where that level is. And not until this is determined is it fair or reasonable to express opinions that can be construed by the general agricultural public to be scientific fact.

My plea, therefore, made in the interests of the intelligent, rational prosecution of a sound research program, is this: Let us stop arguing over economic questions that can only be settled through the accumulation of adequate data, and let us join all available forces to the end that such data be assembled, analyzed and intelligently interpreted.

Barn Ventilation with Electric Fans[1]

By A. W. Clyde[2]

THE purpose of this study was to get additional facts on which to base the design of wall construction and the ventilation system of dairy barns. It was not primarily the testing of electric fans. Rather the fans were used as a convenient means of getting at the relations between heat production, wall construction, temperature, rate of air change and humidity. No attempt was made to decide what conditions are ideal for cows. Until that question is settled we must of course be guided by judgment of dairymen as to what conditions shall be provided.

Perhaps my purpose can best be illustrated by a specific case. Suppose a man describes a barn to us. He will keep 25 cows in it. No condensation is to be allowed except on windows, and the temperature must never get below 35 degrees. He asks us to tell him how well insulated the walls must be and how much air must be moved through the barn. If he should be willing to permit a small amount of condensation on the walls in the coldest weather, then the answers would be different than if no condensation were permissible.

It has been pointed out many times in ASAE meetings that animal heat is limited. Ventilation, as we now have it, removes heat from the barn. Therefore, we cannot have unlimited ventilation in an ordinary poorly insulated barn without having a cold barn. Ventilation is so tied up with heat production and with control of temperature and humidity that it cannot be separated from them.

In the past we have considered that any heat available in a barn is used or lost in one of two ways: First, by transmission loss through the parts of the building exposed to lower temperatures (which is all loss), and second, by warm air leaving the barn whether it be by leakage or by intentional ventilation.

Attempts in the past to balance the heat production with the losses have not been entirely satisfactory. Such computations by Calderwood (4)[3] and Kelley (7,8) have been published. Strahan and Marsh (9) also reported last year that the method they suggested was not numerically accurate. Conditions in actual barns were sometimes better than their method would indicate. Apparently we have not had good enough information on heat production, or some factor hitherto unrecognized affects the results.

The mathematical statement of the foregoing is:

$$H = \frac{VD}{53} + ACD$$

in which H = Heat produced in barn (Btu per hour per cow)
V = Rate of air change (cubic feet per hour per cow)
A = Exposed area of barn (square foot per cow)
C = Average heat transmission coefficient (Btu per hour per square foot per degree difference in temperature)
D = Difference in temperature.

This equation applies to steady conditions. It does not apply, however, if either inside or outside temperatures are changing. In such cases the walls and other parts of the building are either warming or cooling. They are therefore taking up or giving off heat. Less heat or more heat than the cows are producing is thus available at that time. During most ventilation tests the temperatures are changing. The heat capacity of the building must then be considered. The formula cannot then be used unless it is modified to include the warming or cooling of the building. This has not been done in the past. It accounts for some of the discrepancies in previous heat calculations. It is one of the things to be included in this study.

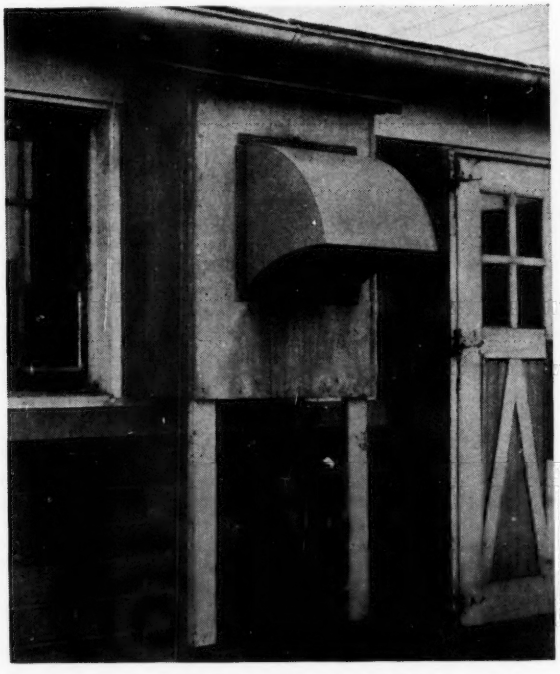
Many good dairymen have never accepted the idea that it is best to provide a certain degree of air purity in the barn regardless of what happens to the temperature and humidity. As a rule they restrict ventilation if necessary in cold weather so that the barn temperature will not get below a certain point. They consider temperature control more important than a high standard of air purity or a low humidity. Probably they are right in this belief. It has never been proved conclusively that cows are likely to be injured by what we call impure air. Experiments with poultry at the Iowa Agricultural Experiment Station indicate that temperature control is much more important than air purity.

We now have trustworthy information as to the heat produced by cows at temperatures of 60 to 70 degrees (Fahrenheit). There is practically none, however, about the heat produced at lower temperatures, 35 to 40 degrees. Probably heat production is stimulated at lower temperatures.

So far as the author can learn, no attention has been given to the possibility of using the heat of vaporization

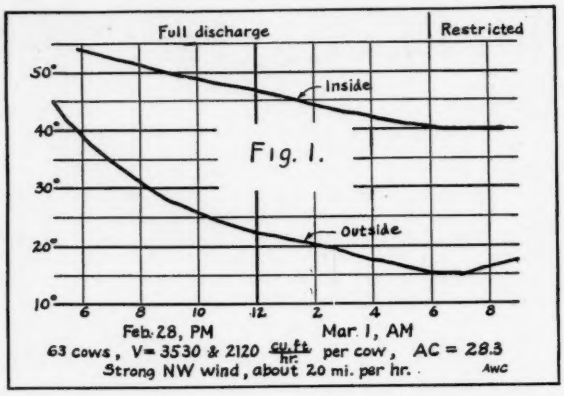
[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1930.

[2]Associate professor in agricultural engineering, Iowa State College.



This shows a temporary installation of one of the fan and damper units of the Louden automatic electric ventilation system used in the test at Iowa State College, the results of which are set forth in the accompanying paper by Mr. Clyde. Both fans were placed in the window openings in the east wall

[3]See citation of literature at end of this article, page 14.



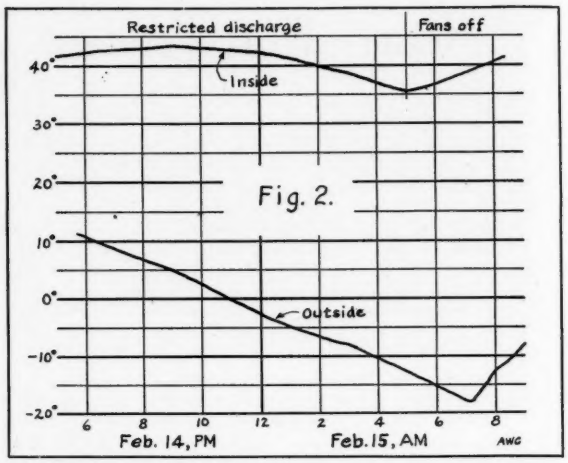
given off by cattle. Armsby and Kriss (2) report this as being about one-fourth of the total heat produced by dairy cows. Forbes (5) reports it as being as high as one-third of the total in some tests with steers. In the past the effort has been to carry the water vapor out of the barn without allowing it to condense, thus losing the latent heat contained in it. It will be realized that this is a considerable item when it is remembered that each pound of water vapor contains 970 Btu and that a milking cow gives off ⅔ to ¾ pound of vapor every hour. This can only be regained by condensing the vapor. It does little good, however, to condense it on the walls. If the walls are cold enough to condense the vapor, then they are conducting more heat out of the barn than is gained by the condensation.

In a gravity system of ventilation the warmth of the air is used to move air. When an electric fan is used, the heat in the air moved is simply thrown away. This air contains more than enough heat, including heat of vaporization, to warm the incoming air to the full temperature of the barn. If the exchange of heat could be made, it would then be possible to keep the barn warmer, or to circulate more air, keep the humidity lower, use a rather poorly insulated wall and still keep the wall dry. These possibilities will be discussed more fully later.

The method given by Strahan and Marsh (9) for deciding how much air must be circulated to avoid condensation on a wall is essentially correct, if condensation occurs whenever the temperature of the wall surface is lower than the dewpoint of the adjacent air. It may be, however, that condensation does not occur until the wall is a few degrees cooler than the dewpoint. Any movement of air would probably hinder condensation as the circulating of air next to a window helps to keep the window dry. If the wall surface can be appreciably cooler than the dewpoint, before condensation starts, then the relative humidity in the barn can be permitted to go higher. This was also one of the relations studied.

An idea that may need modifying is that all condensation of moisture in a barn is harmful, particularly that it hurts the animals. If the animals keep dry and have fairly dry bedding it is hard to see how water nearby would hurt them. We would not think it harmful for them to stand near a lake or river. There are objections to a wet wall, however, such as the following

1. Rapid decay of wood and rusting of steel.
2. Probably more favorable conditions for germ growth.
3. A wet wall often conducts heat faster than the same wall if dry.
4. Often the fact that a wall is cold enough to cause condensation indicates that it is conducting away more heat than can be afforded. With such a wall it may be necessary to have a cold barn in cold weather, or else shut off all ventilation in trying to keep the temperature up.



A Louden automatic electric ventilation system described last year by Strahan and Marsh (9) was used in a 3½ months' test at Iowa State College. Two fan units were installed in the east wall of the college dairy barn. They took air from about 6 feet above the floor. Shutters were used at first but gave trouble by freezing either open or shut. They were therefore replaced by hoods. Since air flow was measured as discharged by the fans it was important to get their discharge as accurately as possible. Over 250 airmeter readings were taken under different conditions to get fan discharges. It was also important that no air leave the barn in other ways. Nineteen intakes were therefore provided with anti-backdrafting valves.

The barn is one story 40 by 130 feet outside with stalls for 64 cows. It has 8-inch walls of ordinary two-cell clay block. A feed barn gives some protection on the north end, but most other factors make for a high heat loss. The glass area is large, being 5 square feet per stall. No storm sash were used, except one put on for comparison. The ceiling was not insulated at the start. The first calculations of heat transmission showed that it needed insulation badly. A 40-degree difference in temperature and only one air change per hour would probably use all the heat the stock kept there would produce. Half of the transmission loss was through the ceiling and roof. It was therefore decided to insulate the ceiling with 4 inches of shavings. It was calculated that this reduced the heat transmission loss for the barn one-third.

Time does not permit giving details of computing the transmission losses. In general, the method given by Harding and Willard (6) and the ASHVE (1) was followed. Their figure of 0.3 for the U of an 8-inch clay block wall was not used, however, as there is considerable evidence that it is too low for this wall. The figure 0.4 was used instead, and I feel sure it is none too high. Heat losses were figured for a 15-mile wind as is common heating practice. They were also figured for a more moderate wind (7 or 8 miles), since that was a more common condition. For this condition the outer surface coefficient, K_2, was taken as two and one-half times the inner K_1 instead of three times. Inasmuch as insulation of the ceiling extended over some time and as the number of cows in the barn varied somewhat the values of AC had to be figured for the particular conditions each night. The floor was not included in the heat loss because it may give a loss or gain depending on barn temperature. This is discussed later.

The number of animals varied from 60 to 64. They differed from an average herd in the large number of young stock. At the start of the test they were as follows:

25 milkers, averaging 1075 pounds in weight, and 25 pounds of milk per day
9 dry cows, averaging 1025 pounds in weight
29 heifers, averaging 862 pounds in weight.

These figures are fairly typical of the entire test, except for an increase in average weight of about 40 pounds during the first two months, followed by a decrease. It should be noted that less heat would be expected from this herd than from one having a larger percentage of milkers.

Practically a continuous record of inside and outside temperatures was kept for 3½ months with recording thermometers. These were checked frequently. On several occasions I stayed at the barn a considerable part of the night to get data on average barn temperatures, humidity, etc. The herd was let out twice a day for water; therefore test periods were limited to nights.

The first method of analyzing the results was to calculate the heat leaving the barn. The equation. $H = (VD \div 53) + ACD$, may give the impression that H is the heat being produced by each cow at any moment. There may be times, however, when the floor may be absorbing or giving up heat, also when the other parts of the building may be acting similarly. I have therefore substituted the expression HA to indicate the heat available regardless of whether it comes directly from the cows, from the earth under the floor, or from any other source.

A glance at the temperature records shows that the typical night is one of changing temperatures outside and to a lesser extent inside (Figs. 1 and 2). If the formula is applied to such conditions we can get very misleading results. In order to avoid confusing such conditions with what could be maintained steadily, the steady conditions were summarized first. Twenty-one nights were sorted out when fans were running open and when conditions seemed to have reached equilibrium (Fig. 3). Eleven other nights seemed suitable for restricted discharge (Fig. 4). Also, seven nights similar to Fig. 5 were selected when the fans changed during the night but inside and outside temperatures were not greatly different at the finish than at the start. The average HA for 14 or 15 hours was figured for the latter, assuming one air change per hour when the fans were off. The results were as follows:

	HA, Btu per hour per cow	Average barn temperature, degrees
21 nights full discharge	2038	52.7
11 nights restricted discharge	2414	42.9
7 entire nights	2605	43.2

More than half of the nights involved constantly changing temperatures like Figs. 1 and 2. In the typical night the outside temperature drops until about 7:00 a.m., while the inside temperature drops more slowly. This plainly introduces the heat capacity of the barn as a factor. When air temperatures change, the temperature of the walls and other parts of the barn must also change. This results in either the giving up or absorption of heat. The heat capacity of the building thus acts as a governor tending to hold the barn temperature steady. If the barn temperature is allowed to fall, then more heat is available for a while to add to the heat from the cows and tide over a drop outside. This is such a common occurrence that the author has tried several methods of making a mathematical statement of it. Attempts to figure the number of pounds of material times specific heat times temperature change have been unsatisfactory. Even without including the floor the barn has about 52,000 pounds of masonry and nearly 28,000 pounds of lumber and shavings. Using specific heats of 0.2 and 0.5 from Allen and Walker this material would give off 24,300 Btu, or 380 Btu per cow for each degree lowering in temperature. One difficulty in applying this method is that probably the floor and earth under it also have a part. No information has been found as to how great this part might be. A second difficulty is that we do not know how rapidly the building gives up its heat. No doubt the temperature of walls, etc., would lag behind the air temperatures but how much is uncertain.

Another attempt to evaluate this stored or residual heat was to see how much more available heat there was on nights of falling temperature as compared to steady temperature. For example, with restricted fan discharge 62 cows could maintain a D of about 36 degrees after the ceiling was insulated. On the night of February 14 there was an average D of 44½ degrees for 8 hours (9:00 p.m. to 5:00 a.m.). The extra 8½ degrees would represent additional heat of 580 Btu per cow per hour if figured in the usual way. Smaller values ranging down to 175 Btu were found for other conditions. This method, however, is subject to question because of uncertainty about the heat transmission loss under changing conditions.

Still another line of approach was to see how fast the inside temperature lowered as compared with the outside. The starting point was chosen when D had a value that would be about normal for steady conditions. With fans on full discharge for 21 nights and periods of 6 to 14 hours the average inside drop was 0.57 degree for each degree drop outside. For restricted discharge the average of 5 nights and periods of 8 to 15 hours was 0.31 degrees drop inside for each degree drop outside. For the latter condition only 5 nights seemed suitable because often the fans would not start until D was above normal for steady conditions.

Another phase of changing temperatures is given in the discussion of results.

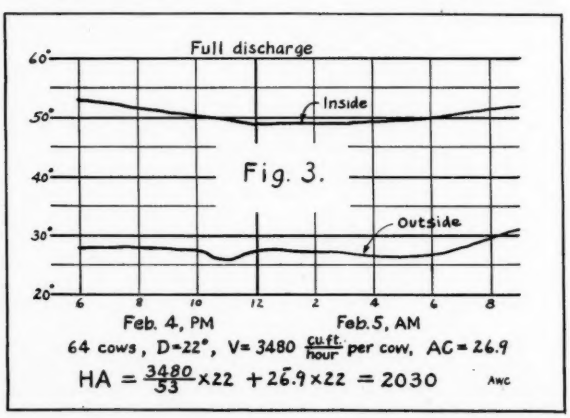


Fig. 3.

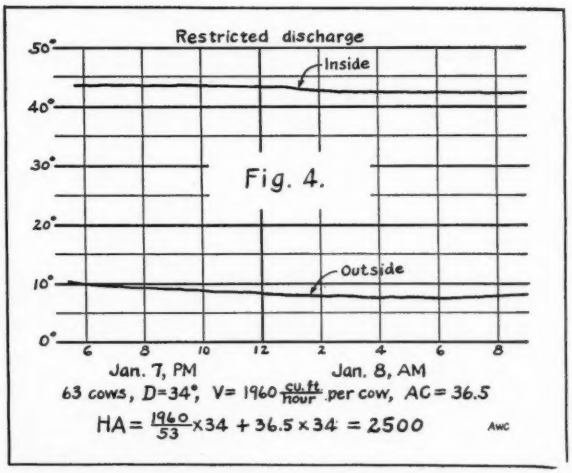


Fig. 4.

Considerable work was done in analyzing moisture relationships and calculating moisture leaving the barn. A wall panel was also observed to see if condensation started at the theoretical point. This panel was made of Insulite, varying in thickness from ¼ to 1½ inch by ¼-inch steps. During cold spells this was watched to see exactly when condensation first started. The temperature of inside surfaces was computed and a sling psychrometer was used as close to the wall as possible to get the humidity. On one occasion condensation started when the wall surface was computed 1 degree below the dew point of nearby air, but on four occasions no condensation appeared until the wall was 3.4 to 8 degrees colder. This needs further study under more controlled conditions.

Another phase of condensation work was to get some idea of the latent heat released by condensation on windows and walls. The heaviest frost deposit was on January 18 after 62 hours of below zero weather and little ventilation. The frost and ice was removed from a typical window and weighed. It was about 3½ pounds per animal. Adding 2½ pounds estimated on walls gave a total of 6 pounds per cow. This figured about 100 Btu per cow per hour for the 58 hours the cows had been in the barn. It is considerably less than I expected. It indicates that latent heat liberated by condensation is a small item even though there was heavy frosting on the single windows and clay block wall.

It is interesting to compare the results on "heat available" under steady conditions with two estimates made early in the winter. One based on the feed being eaten January 1 using data from Armsby and Kriss (2) gave an average of 2040 Btu per hour per animal after deducting latent heat. The other based on the milking cows as suggested by the same authors and on a typical ration for the dry cows and heifers was as follows:

25 milkers, at 2250 Btu per hour—	56,300 Btu
9 dry cows, at 2040 Btu per hour—	18,360 Btu
29 heifers, at 1770 Btu per hour—	51,330 Btu
	123,990 Btu

Average, 2000 Btu per hour per animal.

These estimates are practically identical with the average of the 21 nights when the barn was at 52.7 degrees. The other nights when the barn was cooler give higher figures. Fig. 6 shows the heat available plotted with barn temperature. There are variations which are hard to explain, but in general there is a distinct tendency for high heat available and low temperature to go together.

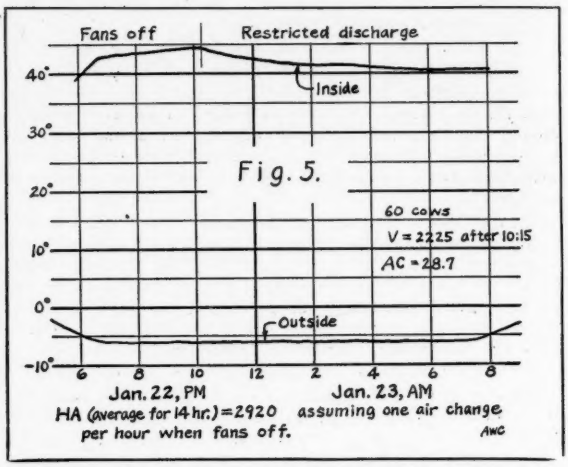
The author believes this is due to three things:

1. Latent heat liberated by condensation
2. Greater heat production by cows at lower temperatures
3. Flow of heat to barn from the earth underneath.

As there was considerable frosting of windows and walls in this barn in cold weather some latent heat was made available. It was a rather small item, being probably not much over 100 Btu per hour per cow under extreme conditions. With a poorly insulated ceiling it might be considerably higher.

It was mentioned earlier that available data on heat production is mostly at 60 to 70 degrees. It seems reasonable to expect more heat production at lower temperatures. This experiment, however, did not show how much extra heat might be coming from the animals and how much from the earth.

I believe that the earth under the barn is a factor which has been given little attention heretofore. This barn had a concrete floor on the ground with most of the stall platforms of cork brick or wood block over the concrete. If the earth temperature under the floor is about 50 degrees, there would be a flow of heat into the barn over most of the floor when the air in the barn was below 50 degrees. The stall platforms act differently. Kansas experiments (3) show that nearly all the time, and particularly when a cow is lying down, the platform is warmer than the earth and so the flow of heat there is out of the barn.



This loss of heat is, no doubt, reduced by bedding and by materials like cork brick and wood block. The air near the floor is usually a little cooler than the barn average.

It is probable, therefore, that for the usual concrete barn floor there is a neutral barn temperature of about 50 degrees at which the loss and gain would offset each other. Above that point some of the cow's heat would be lost to the floor. Below that point there would be a gain of heat. This is fortunate because it gives extra heat when most needed.

There appear to be several reasons for the different results secured during nights of changing temperatures. One might be the conditions during the day. If the sun had been shining on the roof and walls they would probably be warmer at the start of the test period than if the day had been cloudy. Another factor would undoubtedly be the gain or loss from the floor. If the fans started when the barn was 46 degrees then comparatively little heat would be coming from the floor. As the temperature lowered more heat would be expected from this source. This changing amount of heat as the barn temperature changes makes the study of such tests a difficult problem, particularly when there is little information as to how fast the floor and walls respond to changes. It is a phase of the subject which needs further study. Thermometers placed at various points in the floor and walls would seem to be necessary for this purpose.

The effect of the heat capacity of the barn is also seen in the frequency with which the thermostats act. Seven or eight degrees were necessary to make them act. That is, if the barn cooled to 38 degrees and shut off the fans, it would have to rise to about 46 degrees to start them again. If it were not for the heat capacity of the barn, it would usually not take long for it to warm that much. It was unusual, however, for the fans to start again that night if they were shut off. In fact, the inertia effect of heat capacity works both ways. When outside temperature is falling it keeps the fans running on an abnormal *D*. It then resists the warming of the barn and postpones the starting of the fans. More sensitive thermostats would make for more uniform temperatures and humidities in the barn. (More sensitive thermostats are now being provided on this system.)

SUMMARY AND CONCLUSIONS

1. Fans with automatic control by temperature are a promising development in barn ventilation. When placed in the side of the barn away from prevailing winds and used with anti-backdrafting inlets, the wind had little effect on them. Certainly less attention was required than would be needed with a gravity system under different weather conditions. In this 64-cow barn, running an average of 16.8 hours per day, the power used was ⅓ kwh

(kilowatt hour) for each hour of running, or 2.6 kwh per cow per month. Tests this past summer have shown that this power can be reduced by changes in fan blades and motors.

While the temperature regulation was usually satisfactory it was evident that thermostats reversing on 2 or 3 degrees would give closer regulation under changing conditions than the 7 or 8-degree thermostats used. As mentioned before this change has now been made.

2. This study shows with present methods at least the utter impossibility in this climate of putting dairy cows in a poorly insulated barn and expecting them to keep it above freezing if the air is changed very often. To be specific, something better than a single boarded wall or an ordinary 8-inch masonry wall is necessary in barns of ordinary size. If the walls conduct heat rapidly, much change of air in cold weather causes a cold barn. If the ventilation is restricted to secure warmth then the humidity goes very high. If we demand dry walls in addition to warmth, good insulation is doubly important. The ceiling area is so large that it must be insulated with hay or other material for satisfactory results. (There is nothing new to students of ventilation in this statement, but many others do not appreciate it fully enough.)

3. The heat available for ventilation and for transmission losses is not constant but variable. It may be more than the cows are producing, or it may be less. This is particularly true if the barn floor is in contact with the earth and we do not include the floor in computing the transmission loss and AC of the barn. It is possible to include the floor in AC, but if that is done there will be a different AC for each different barn temperature. Until more is known about flow of heat to or from the floor it is more convenient to figure AC for walls and ceiling only. Gain or loss from the floor is then considered as adding to or deducting from other sources of heat.

If calorimeter figures for heat produced by cows at 60 to 70 degrees are made a basis, they can be modified as follows to estimate heat available:

1. Latent heat liberated by condensation. In this barn 100 Btu per cow per hour seems to be as much as could be expected from this item under the worst conditions even though there was considerable frosting on the large area of single windows and uninsulated walls. When frost is being evaporated it takes up heat of vaporization and decreases the heat available.
2. Probably increased heat from cows at barn temperatures below 60 to 70 degrees.
3. Gain or loss from floor in contact with the earth.

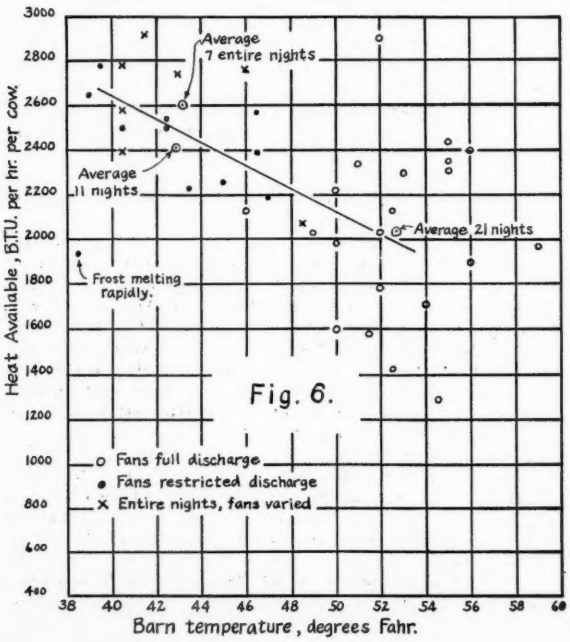


Fig. 6.

The second and third items were not separated in this expermiment because little seems to be known yet about the second. If the barn is above the earth or floor temperature (about 50 degrees in this locality), heat is lost to the floor, but if below this point there is a gain. When the barn was about 53 degrees the loss to the floor probably neutralized any increased heat production, thus making the heat available the same as calorimeter data would indicate. When the barn was at about 40 degrees, these items combined seemed to add about 450 to 500 Btu per cow per hour in addition to 50 or 100 Btu added by condensation. These figures might be slightly high for average barns which are narrower than 40 feet and thus have less floor area. There can be no doubt, however, that the three factors combined make considerably more heat available if the barn is kept at about 40 degrees than is available for 50 degrees or more.

When temperatures are changing a fourth factor appears, namely, the heat capacity of the building. It acts as a governor to keep the barn more uniform than the outside. Its influence disappears a few hours after conditions become steady, but it is important in tiding over a short cold spell. Because of the many combinations of conditions it does not yet seem possible to put a numerical value on the extra heat from this source but values of several hundred Btu are indicated for short periods. Probably this factor would be smaller in frame barns than in those with masonry walls.

The practical effect is that it is unnecessary to provide for the coldest weather which may last only a few hours. The coldest last winter at Ames was 22 degrees below zero, but that was of short duration. There were 28 hours continuously below 10 degrees below zero. Since such temperatures must be expected here it would seem reasonable to provide for at least 12 degrees below zero, figuring the barn at the lowest temperature permissible. Thus, if 35 degrees were the absolute minimum for the barn a D of 47 degrees would be provided for.

4. Condensation did not appear on the test panels until the computed surface temperature was lower than the dew point of the nearby air. On one occasion there was very slight condensation when the surface was 1 degree below the dew point, but on four occasions the surface was from 3.4 to 8 degrees colder before the slightest condensation appeared. This was probably due to the circulation of air. Further investigation is needed along this line if exact results are wanted. If dry walls are demanded, the general method proposed by Strahan and Marsh is the logical method to follow. A correction should be made, however, for the fact that air expands when warmed, therefore less moisture enters the barn than they figured. This experiment indicated that it might be safe to let the computed wall surface temperature be a little below the dew point of the air. Another view is that absolute freedom from condensation on walls may not be worth the cost, particularly with masonry walls. There is not much objection to a little condensation during the most extreme weather if other conditions are satisfactory.

5. One of the most interesting possibilities of electric fan ventilation is in saving the large amount of heat now wasted. In a gravity system the sensible heat of the outgoing air is used for power, but when electric power is substituted this heat is simply thrown away. The heat of vaporization is entirely lost in either case if no condensation is permitted in the barn. This heat of vaporization is an item of considerable size, being at least one-third as much as the sensible heat produced by cows. The heat of fusion might also be secured by freezing the moisture. In cold weather the relative humidity is usually high, therefore, most of the water vapor would be condensed when cooled to the outside temper-

ature. When all heat is included, the outgoing air contains enough to heat the incoming air to the barn temperature with considerable left to cover inevitable losses. It, therefore, seems wasteful to throw away all such heat. It would not be expected that it would be practicable to heat incoming air to the full barn temperature but certainly it could be warmed considerably.

To get an idea of how much heat was wasted in this test let us figure on a 24-hour period when air leaving the barn might be equal to that moved by restricted discharge of the fans for 18 hours with a temperature difference of 37 degrees. The sensible heat in outgoing air would be ([18 x 2225 x 60 x 37] ÷ 53), or 1,680,000 Btu. The latent heat would be about ([18 x 64 x 700] — 806,000) Btu, making a total of about 2,486,000 Btu. If it had been furnished by coal burned at 60 per cent efficiency, it would have required at least 300 pounds of coal per day, or at the rate of 4½ tons per month. It might be about the same on full discharge with a smaller temperature difference because then the smaller heat available is mostly offset by the smaller transmission loss. It is a conservative estimate for an average 64-cow barn because of the large number of heifers and consequent low heat production in this barn.

There is no question as to the possibility of using some of this heat instead of throwing it away. The only questions in my mind are as to what is the best method of doing it, and whether or not it can be done at a reasonable cost. No attempt has been made to work out details, but possibly such a device might consist of two concentric tubes, one for outgoing and one for incoming air with the flow in opposite directions. The problem would seem to be mainly one of getting enough surface and time for the heat transfer to be made. Probably some means would be necessary to give some degree of air turbulence. If the barn were tightly built probably only one fan would be needed but if not, fans would no doubt be needed in both inlet and outlet. Another possibility is in making the heat-exchanging surface also serve as part of the wall. Some easy means might also be needed to permit removal of frost from the device because it would accumulate in cold weather.

The heat saved by such a device might be applied in two ways as follows:

1. To increase barn temperature with a certain wall and amount of ventilation
2. To increase ventilation and secure a certain temperature with a cheaper wall, yet keep the wall dry.

In either case, or a combination of the two, the result would be that certain barn conditions could be secured with a wall of lower insulating value than is now necessary.

Literature Cited

1. Amer. Soc. of Heating & Ventilating Engineers Guide, 1929. Published by the Society, 29 W. 39th St., New York, p. 10-18.
2. Armsby, H. P. & Kriss, Max. Some fundamentals of stable ventilation. Jour. of Agr'l. Research 21: 343-368. 1921. Also Agr'l. Eng'ng. 2: 151-156, 174-177. 1921.
3. Bainer, Roy. A temperature study of dairy barn floors. Agr'l. Eng'ng. 11: 187-190. 1930.
4. Calderwood, J. P. Memoranda of computations of the test data in a Canadian barn. Agr'l. Eng'ng 1: 78-79. 1920.
5. Forbes, E. B. and others. Further studies of the energy metabolism of cattle in relation to the plane of nutrition. Jour. of Agr'l Research 40: 37-78. 1930.
6. Harding, L. A. and Willard, A. C. Mechanical equipment for buildings, v.l., heating and ventilation N. Y., Wiley, 1929. p. 178-184.
7. Kelley, M. A. R. Test of a fan system of ventilation for dairy barns. Agr'l. Eng'ng. 2: 203-206. 1921. Also A.S.A.E. Transactions. 1921. 15: 114-122.
8. Kelley, M. A. R. Ventilation of Farm Barns. U. S. Dept. of Agriculture Technical Bul. 187, p. 34-35. 1930.
9. Strahan, J. L. and Marsh, C. A. Ventilating stables with electric power. Agr'l. Eng'ng. 11: 127-134. 1930.

Agricultural Progress[1]

A GLANCE at the part government has played in the development of agriculture suggests a question or two. The Homestead Act of 1862 contemplated that all who wanted land might have it, and thereby caused the swift settlement and quick cultivation of every suitable area in the nation. Abraham Lincoln also signed the Morrill Act, from which the vast plants of our agricultural colleges have grown. Then came the experiment stations, and the Department of Agriculture in its full stature. Eventually the extension system of agricultural education came into flower, along with 4-H clubs and vocational high schools.

Every American may well be proud that these agencies have flourished so splendidly. Without them certainly the country would be less advanced, and less able to cope with its problems.

To support the work of these various institutions, we have expended many hundreds of millions of public funds. And whoever presumes to say that we have not had our money's worth would indeed seem foolish. Yet, after many decades of very great expenditures, all intended to improve and advance the welfare of agriculture, we hear spokesmen for the industry today complaining more bitterly and more vocally than ever about its alleged unprofitableness. The huge sums that have been appropriated year after year for the Department, for the colleges, for extension work, and the earnest efforts of thousands of able workers, from Secretaries of Agriculture down to the humblest club leaders, have not availed to insure a prosperous farm industry, if we are to believe what we hear. If this condition be true, we shall have to look for remedy to more research, more education, better directed to the primary objective, profits. . . . . .

High yields, attained by following the methods worked out by agricultural research agencies, are the most direct means of attaining that desirable element of farm income, volume of output per individual. Few farmers can make money on low yields. Studies of production areas, and studies of groups of successful farmers, alike confirm the contention that high yields are a thoroughly essential factor in farmer prosperity.

A danger does exist, however, that in the encouragement of heavy yields the equally important element of low costs may be overlooked. Possibly a fair criticism could be made that the Department of Agriculture and its cooperating agencies have sometimes failed to keep this in mind while fostering the numerous production contests that add interest to rural affairs. Such contests are held in nearly every state, in connection with nearly every important product, ranging in participation from the 4-H club members to candidates for the 100-bushel corn clubs and the ton-litter clubs. They have been highly useful in establishing new standards of output — far more useful than the computation of averages. There are practical reasons, probably, why these contests should not be held to determine who can make the most profit rather than who can turn out the greatest volume. Yet it is proper to insist that, after all, farmers are in business to make profits and not merely to pile up enormous quantities of foodstuffs regardless of costs.

[1]From an address on "Railways and Agriculture" by Wheeler McMillen, associate editor of "The Country Home," before a recent meeting of the American Railway Development Association.

The Industrialization of Dairy Production[1]

By H. T. Greene[2] and B. B. Howell[3]

ASK a manufacturer what he would consider the ideal in the selection of a commodity to be manufactured on a modern large-scale industrial program, and his answer would be, "I want a commodity with a large potential volume of steady business, a minimum of overloads and underloads, and with a constant supply of raw material."

Essentially, does not dairying fit this definition? Dairy production is today comparatively steady and of large volume. It operates seven days a week. Raw materials in the shape of forage and grain are available, and cows are available to turn them into dairy products which enjoy a ready marketability. The solution of the problem of industrializing dairy production, however. is not so simple. It is a problem full of unknown factors, the study of which is almost an engineering paradise.

Dairy production as a general rule today is conducted by individuals milking small herds ranging from an average of around ten cows in New York state to sixteen cows in Wisconsin and about fifty cows in California. It is noteworthy that the size of the herd is largest in the newest agricultural sections.

Trends in dairying are toward higher quality production, quality being measured largely by sanitary precautions. The public wants good dairy products, but the definition of "quality" has often been mostly in the advertising field rather than based on actual conditions. A new factor is in producing dairy products of higher nutritional quality. In the production of milk of high sanitary and nutritional value, industrialized dairy production becomes a necessity.

Let us say the average dairy farmer produces 250 pounds of milk daily. To make 30,000 pounds of milk daily involves one hundred and twenty farmers whose abilities vary considerably. Is it possible to make a high grade milk of uniform quality with this range of production? One poor producer will lower the grade of the entire supply. Milk distributors today, in furnishing the public with the so-called special or intermediate grades of milk are forced to employ large staffs of inspectors and technicians to supervise their supply with periodic inspection, and even then complain of their difficulty in maintaining proper control. Elimination of this expensive technical staff would alone aid in reducing the basic cost of milk to the distributor.

An industrialized dairy production unit will be a large-scale proposition. No one can forecast the ultimate size. It must be self-contained in its control and management. This demands a plant large enough to keep the specialists in charge of control work busy and to afford competent management. It must produce the highest quality product at a reasonable cost, which demands efficiency and economy of operation.

The principal factors necessary to consider in an industrialized dairying system are manifold. The first is health of cows. It is an axiom that healthy cows are necessary to quality milk. One element conducive to a healthy cow is comfort. The modern steel stanchion and stall is simply a modern development of an old type. One may well ask, Is it necessary to tie a cow in a stanchion?

In the matter of temperature, ventilation and humidity of stable air, a startling lack of concrete knowledge is evident. Work on the optimum temperature, air movement and humidity is just starting. An industrialized dairy unit would of necessity have to recognize and control these factors to secure proper results in health of cows and production. In our own experience a sharp drop in barn temperature gives a marked decrease in milk flow, often reaching ten per cent. Extremes of heat create the same condition. Take, for example, a herd of a thousand producing animals. Probably the output would be around 27,000 pounds. A ten per cent shrinkage on this poundage is 2700 pounds, which at only $2.00 per 100 pounds is $54.00 daily loss, with feed and labor costs the same. The moral of this needs no comment. High humidity in barns seems correlated with pneumonia in our records. Consecutive days of heavy fog in spring and fall are followed by pneumonia cases. We have seen seven per cent of a herd in one barn affected under extreme conditions.

The amount of light needed in barns seems entirely unknown. Sanitary engineers in their codes specify a certain number of square feet of glass per cow, yet in parts of the United States this is far too much, and in other parts probably not sufficient. No relation exists in their minds as to the effect of glass surfaces on temperature control.

The exercise needed by a cow is a much debated question. It seems reasonable that a cow should receive some exercise, the amount and control of which are open to investigation. Professor Babcock has suggested to us the possibility of using a cow's exercise period to furnish power.

Disease control in a large herd exhibits some difficulties. Any large population, whether at an army camp or in a cow barn, has some very definite public health

[1]Paper presented at the meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, Chicago, December, 1930.

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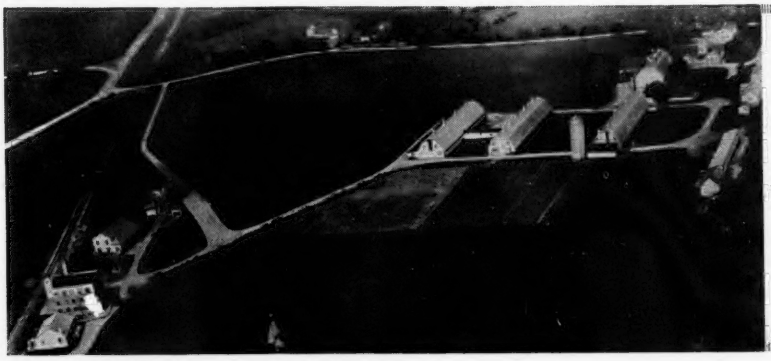

An airplane view of Brook Hill Farm showing the arrangement of the various units comprising this industrialized dairy plant. From their experience in building up this unit the authors say it is an engineering problem to correlate and utilize in a finished plant the many and varied factors involved in industrialized dairy production

problems. Disease control and elimination of spread of infection must govern the design of an industrialized dairy unit.

A factor in which an industrialized plant could make a real showing would be in quality of product. The sanitary features of this plant in the elimination of possible dangers are important. Laboratory control over the product from the raw material to the finished product is possible. The entire elimination of the human contagion factor and the human equation is an interesting possibility. Absolute health control over cows is becoming an accomplished fact. It still needs a quick test for milk so that milk can be drawn from a cow, checked and the cow approved at the beginning of each milking. Control over human and animal contagion and the elimination of the human factor in milk production might well upset present day standards demanding the pasteurization of commercial milk.

The improvement of the nutritive quality of milk by control over the feed given the animals is a new phase in furnishing the public a better milk supply. Workers in nutrition reveal a definite relationship between the vitamin value of feed and the vitamin value of milk. Preliminary work in our laboratory is showing some other factors subject to improvement.

Undoubtedly one of the foremost reasons for industrializing any industry is to make more efficient the labor involved. The factor of labor organization on an industrialized basis is probably better developed on the large-scale dairy farms of the country than any other factor today. For instance, not many years ago practically all milk was produced on a farm where one man, with possibly a helper, was herdsman, feeder and milker. Later, with the introduction of large-scale dairying, the "gang" system developed, and the feeding and milking were done by separate crews of men, each expert in its particular work. In most other respects large-scale dairy farms are an expansion rather than a development of the ten-cow unit. Our own time studies have shown that the actual operation of milking involves only 46 per cent of the available working time, while idling between jobs and miscellaneous work, probably wasting time, is 16 per cent of the total. All essential operations could be shortened by time studies correlated with barn design.

The extent to which a dairy cow herself can be industrialized is as yet unknown. Some of the leading dairymen of the country are of the opinion that the human interest element and considerable individual attention are fundamental to satisfactory production. It is in this respect that dairying differs from the manufacture of automobiles.

MATERIALS HANDLING PROBLEMS

Probably few people realize the tonnage which must be handled to and from any industrialized herd. In this respect the engineering phase is again very striking. For the purpose of showing concrete figures, we shall choose the 1000-cow unit and compute the approximate tonnage to be handled per day. Assuming average conditions, the figures are as follows: 30,000 pounds of ensilage; 16,000 pounds of hay; 7,000 pounds of grain; 85,000 pounds of manure; 8,500 pounds of bedding; 27,000 pounds of milk; 75,000 pounds of drinking water; 175,000 pounds of air actually breathed, and 11,500 pounds of water given off through the skin. This gives a total of 435,000 pounds or 217 tons per day.

When we consider that over 85 tons of silage, hay, grain, manure, bedding and milk must be handled to and from 1000 cows individually per day, we realize that this is truly an engineering problem. The ventilation problem has been included in this discussion of handling materials since it deals with the moving of nearly 100 tons of raw material per day to and from our fundamental machine, the cow.

As will be discussed later, it is probable that the industrialized plant would be located near the limits of a large city. This would make the disposal of the manure an important problem. At the present time the manure from a large dairy plant is being dried on a commercial scale with successful results. This development, however, requires much additional attention before it can be most profitable. Perhaps the most important problems to be met in this utilization include the use of a suitable bedding, the designing of a satisfactory drier, and the preserving of the fertilizing constituents of the manure. We may also add that the development of this phase of the industry promises a substantial net income to the plant.

A continuous supply of feedstuffs of uniform quality is necessary. This is not as easy as it sounds. Grain used in feeding dairy animals is fairly well standardized, but the roughage part of the ration varies between wide limits. The U. S. Department of Agriculture in making standards for hay has helped the situation. Still any buyer of No. 1 alfalfa hay knows the variation apparently possible under this grade. In our work we have turned to the artificial drying of hay as a means of settling this difficulty. It will soon be entirely possible to obtain hay of definite quality.

ARTIFICIAL DRYING OF HAY

Artificial drying of hay has opened up some very interesting fields. We have been successful in growing rye, oats and timothy and feeding these crops in competition with U. S. No. 1 alfalfa. It has been especially true, as pointed out by Otterson, that when the crop is fertilized by heavy applications of nitrogen it results in a high protein content. It is cheaper to buy nitrogen in the form of fertilizer than in the form of a high-protein concentrate. It appears possible to substitute dried hay of proper quality for at least a part of the grain ration.

Corn silage may have to be eliminated from the ration if the industrialized dairy plant is located on high-priced land. The drying of the whole corn plant into corn hay is entirely feasible and our results have shown it more valuable as a feed than corn silage.

As is the case of any factory, the location of the plant is of basic importance. At the present time, it seems that the immediate objective of the industrialized dairy would be to supply a large city with fluid milk. After considering the supply of labor, fuel and power, together with convenient railroad facilities and distribution of product, it would seem that the plant should be located near the limits of the city it is supplying. Since milk is being handled, the ease of distribution of the product would be of special importance. It is also possible that the advertising value of such a location would be considerable.

Capital, maintenance and depreciation costs per cow are of utmost importance. Too few farmers recognize these costs in present day dairy barn construction. We have no exact figures to give, but we believe investment per cow in the city milk zone is around $150 per milking cow. With the type of construction usually used, the overhead cost is probably not less than $20 per cow. If average production were as high as 6000 pounds, this is a charge of 33 cents per 100 pounds, or ¾ cent per quart. The American Society of Agricultural Engineers in urging more study of this subject is working along the right line.

Development of industrialized dairying is making progress today. The work of Dr. Graves, of the U.S.D.A., and the notable development of the "roto-lactor" at the Walker-Gordon Farms, under the direction of Henry W. Jeffers, all show the trend of the times. Anyone at all interested in working on this new phase of agriculture should become familiar with the work already done.

It has been the sole object of this paper to point out the varied factors of industrialized dairy production. They are worthy of the best minds in the professions of veterinary science, animal husbandry and dairying, but it is an engineering problem to correlate and utilize these factors in a finished plant.

The Need of Reorganization in Agriculture[1]

By W. J. Spillman[2]

OUR present agriculture must undergo radical reorganization during the next one or two decades. The sooner this reorganization can be brought about, the better it will be for all concerned. The reorganization itself is a farm management problem. It is obvious that the professional farm manager and the agricultural engineer may render both an individual and a national service in this crisis, the magnitude of which is limited only by the ability and resourcefulness of the managers and engineers themselves.

In order to make clear why this reorganization must be brought about, and what the nature of the reorganization must be, it is necessary to delve a bit into recent agricultural history.

The present crisis has many characteristics in common with that which followed the Civil War. We can understand our present situation better if we understand the causes of that crisis, and what it was that brought it to an end.

The steel moldboard plow became an effective implement in the late thirties. It multiplied by about one and one-half the amount of land a team could plow in a day, and made possible a better job of plowing. The mower began its career of usefulness in the early forties. It multiplied by five the acreage of hay one man could mow in a day. A year or two later the reaper began to come into general use. It multiplied by seven the acreage of small grain one man could cut in a day.

The two-horse cultivator came in about 1870. It doubled the acreage of corn or cotton or potatoes one man could till. Finally the power thresher, which was developed before the Civil War, underwent marked improvement in the early seventies. It multiplied the grain threshed per day per man by about seven.

These five new implements greatly increased the acreage a farm family could till. They set the stage for a rapid expansion of agriculture. This expansion had begun even before the Civil War, but was stopped by the war.

HOMESTEADING

At the close of that war several million returned soldiers were seeking employment. The federal government gave each of them scrip entitling him to 160 acres of the best farm land he could find. At that time there were many millions of acres of the best farm land in the country available to settlement in the Mississippi Valley. The soldiers of the armies of the South received no scrip, but the new implements were just as available to them as they were to the soldiers of the North, provided, of course, they had the where-with-all to purchase them; neither army was overburdened with cash.

The returned soldiers invaded the Mississippi Valley and preempted land by the millions of acres. At the same time great numbers of people from the farming and factory districts of the East moved to the West and took up land under the then liberal homestead laws. Immigrants from Europe added to the total. The new implements enabled the new settlers to till this land. As a result, the acreage of improved farm land in the United States expanded 50.7 per cent during the decade of 1870-80. During this same decade population expanded only 30 per cent. It was this rapid expansion of agricultural production, much more rapid than the rate of expansion in demand for agricultural products, that brought on the crisis.

During the next decade, ending in 1890, there was an expansion in actual crop area of 31 per cent, while population was expanding 25.5 per cent. During the decade ending in 1900, population increased 20.7 per cent and crop area 26 per cent. But the larger part of this increase in crop area is believed to have occurred during the early nineties. It is probable that by 1896 the rate of increase in crop area fell below the rate of increase in population, thus ending the crisis. Between 1900 and 1910 population increased 21 per cent and crop area 9.7 per cent. This was a period of agricultural prosperity. To summarize, following the Civil War and continuing until about 1896 there was a rapid expansion of agricultural production, far more rapid in fact that the rate of expansion in demand, the result being an agricultural crisis of enormous magnitude. In the latter portion of the nineties the rate of expansion in crop area fell below the rate of increase in demand, and a period of prosperity set in beginning in 1896 and continuing until the World War.

THE VALUE OF GOLD

We have thus explained the crisis that occurred during the latter half of the last century without reference to the changing value of money. Some economists have attributed both agricultural and industrial depressions entirely to the rise in the value of gold. This theory is clearly untenable. If it were true all industries should be affected similarly, but since the World War we have had a notable depression amongst cotton and wheat growers, while until September 1929 our dairy and poultry farmers, representing our largest animal enterprises, were enjoying a period of prosperity.

It is true that a rise in the value of gold causes a general fall in the price level and the effect is felt by industry and agriculture alike. The fall in the price of industrial commodities is advantageous to agriculture because it keeps up the buying power of farm products. But the rising value of gold between 1870 and 1896 also had an adverse effect. It greatly magnified fixed expenses, such as debts, interest and taxes, and thus intensified the crisis. Whether the rise in the value of gold was due to decrease in the rate of world production of gold, or whether it was due to the enormous expansion in the demand for money that came about when millions of new acres were put into cultivation, or to both of these causes, is merely a question I wish to raise but not to answer. At the same time industry was expanding. If gold is a commodity and its price is subject to the law of supply and demand, then the enormous expansion of agriculture and industry which occurred in the seventies, eighties, and early nineties should account for the rise in the value of gold. This rise may, therefore, be mainly a result of the expansion. But it undoubtedly intensified the crisis by its effect in magnifying fixed expenses.

We are now in the midst of another crisis in magnitude similar to that I have just described. For its beginning we must look to the expanding area of wheat and cotton that occurred during and following the World War. Between 1914 and 1919 the acreage of wheat in this country expanded 41.4 per cent; between 1914 and 1926 the acreage of cotton expanded 27.7 per cent. These expansions were due to the high prices that prevailed during

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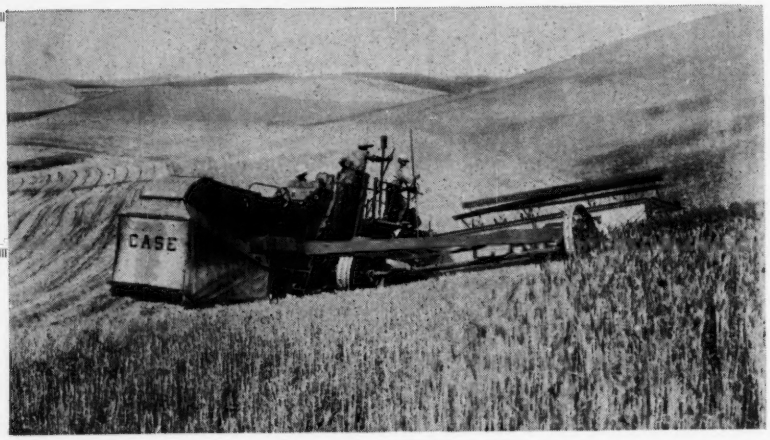
[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1930. The full title given this paper by the author is "The Relation of the Professional Farm Manager to the Present Agricultural Situation with Causes and Duration of the Depression and the Necessary Reorganization of Agriculture."

[2]Principal agricultural economist, Bureau of Agricultural Economics, U. S. Department of Agriculture.



The combine and tractor are two of the machines that are stimulating and making possible the reorganization of agriculture for lower cost production

these periods. So long as war prevailed, and even when the war stopped so long as we were loaning money to Europe with which to buy our products at war prices, prosperity continued. But when we curtailed our loans, Europe could no longer buy our products, even at low prices, although she was sorely in need of them. The resulting enormous drop in demand brought on the present crisis.

Had there been no other developments than those I have mentioned the crisis would not have lasted very long. But there have been developments which, taken together, are at present intensifying and prolonging the crisis. A consideration of these new developments will give us some idea of the length of time the crisis will continue.

In the first place, economic depression is still world wide. Many nations are yet unable to supply their need of imports because of their greatly diminished buying power.

Secondly, during the present century we have learned much about dry farming. It is now possible to grow wheat successfully in a few localities with as little as 10 inches of rainfall. There are vast stretches of country in our western states, not now in cultivation, where wheat can be grown with from 12 to 15 inches of annual rainfall.

NEW MACHINES

Finally, since the World War there has been a tremendous revolution in farm machinery. There are several important items in the list. First is the tractor, which had become a practical implement even before the war.

The necessity of using horses in tilling row crops, and the fact that the horses required to do this could also do the other work of the farm, had prevented the tractor from becoming a major factor in agriculture. It had not replaced any considerable number of horses until about the end of the World War.

The second of the new machines is the automobile. It has almost completely replaced the horse in cities and has nearly eliminated the horse from road work on the farm. The third implement is the truck, which has about finished the horse on the highways. The fourth implement, and most important of all in its effect on the horse population, is the cultivating tractor. It eliminated the necessity of maintaining a lot of horse power for the job of cultivating row crops. With its advent the horse began to disappear from the farm at a rate which was quite alarming to the friends of the horse. From the peak about 1918 to the present time there has been a decrease in our horse population on farms and in cities of some 9 million animals. Along with them disappeared the market for some 25 million acres of corn, oats and hay, which left us with a surplus of these three feed crops. Much could be said on this phase of the situation, but I do not have time for it here. If we had other crops that could be substituted for corn, oats and hay, this situation would right itself. But there are no such substitute crops. There is a possibility that other livestock may ultimately increase in numbers sufficiently to absorb the present surplus of the feed crops.

The last machine in the list responsible for recent technical revolution in agriculture is the combine. Under conditions to which it is adapted it has reduced the cost of harvesting the small grains more than 50 per cent.

These new machines, under conditions most favorable to their operation, enable us to grow wheat profitably with a yield as low as 12 bushels per acre as long as the price remains above about 50 to 60 cents per bushel.

New knowledge of dry farming and new machines have made available a vast but not as yet accurately known area of new wheat land and as much or more new cotton land in our dry farming area, land which at the beginning of this century or even at the end of the World War was not available. While the acreage of wheat and cotton is decreasing in regions of small farms, this decrease is more than compensated for by increase in the acreage in the Great Plains region so far as cotton and wheat are concerned.

It is true that just at present the increase in cotton acreage has stopped, and it is probable that the present price situation in the wheat market will stop expansion of wheat acreage temporarily. But I anticipate that just as soon as the price of either cotton or wheat rises to the point of making the production of the crop profitable in the Great Plains region, the increase in acreage will begin again, and will continue, with possibly many more interruptions due to fall in prices, until the available land is occupied. How long this will continue it is impossible now to say. I believe, however, that the general conclusion is justified that the depression in cotton and wheat will not be permanently ended until all the land has been put in cultivation on which these crops can be grown profitably when prices are sufficient to enable the average producer to make some money. I will not hazard a guess as to the exact date at which the present depression will end. But this date appears to me now to be rather far in the future unless some means can be devised for checking the expansion.

In the case of wheat acreage, a situation similar to that above described exists in Canada, Australia, Argentina, and particularly in Russia. I am informed by those familiar with the situation in Russia that there are some 25 million acres of good wheat land yet to be put in cultivation there. This land must be occupied before we are safe from the danger of overproduction in wheat.

In the case of cotton, there is a situation similar to our own in many parts of southeastern Asia, of southwestern Asia, and in numerous places in Africa.

While the present crisis cannot well end till the rate of expansion into these new areas falls below the rate of increase in population, it is undoubtedly true that any marked increase in the buying power of nations, in which the economic situation is now thoroughly demoralized, would go a long step toward relieving the situation. But

this relief could not well be permanent as long as we keep on expanding production at a rate higher than the rate of increase in the consuming population.

While the present depression is due primarily to overexpansion in cotton and wheat acreage, and to a less degree to the decrease in horse population, resulting in a surplus of feed crops, it has not been confined entirely to these major crops, particularly during the last year.

With the financial crash which came in the fall of 1929, there was an enormous drop in demand for dairy and poultry products, and since that time these two industries have been having their troubles. This drop in demand is believed to be only temporary. With economic recovery in our industrial situation the demand for dairy and poultry products should again become normal.

But there is a more serious situation confronting these two industries. In the region of small farms, where modern labor-saving machinery cannot be used to good advantage, there are some millions of farmers who in the past have depended on wheat as a principal source, or on cotton as practically the sole source, of cash income. The low prices for these two products that have prevailed for the last few years have compelled these farmers to seek new sources of cash income. In nearly all cases the line of least resistance has led them into dairying and the poultry business. As a result, there has been a recent increase of several million dairy cows and of many million hens. The drouth of 1930 prevented a large increase in the production of butter. But when normal weather conditions return, and when the present excessive numbers of young heifers reach maturity, we shall have many more cows than are needed to supply domestic demand. It appears almost inevitable that in the case of butter we shall within a year or two reach an export basis. If we do, it means a drastic drop in prices. If and when that occurs the dairymen, and along with them the poultrymen, will add their voices to the clamour for farm relief which has heretofore emanated mainly from the producers of cotton and wheat.

From what has been said in the foregoing it appears evident that our agriculture must undergo a radical reorganization in order to enable our farmers to reduce cost of production to a point that will let them compete with producers in other countries, as well as in our own Great Plains region.

The work of the professional farm manager and of the agricultural engineer now becomes obvious. In the reorganization of our agriculture their part must be a major one.

REORGANIZATION

The necessary reorganization in wheat-growing regions is now going forward at a rapid rate in those parts of the country where the farms are large, or where new land is being converted from grazing to grain production. In the latter localities the size of the farm may be adjusted to the most economic methods of production.

That important results can be accomplished in the wheat-growing sections of the Great Plains region is amply demonstrated by conditions with which you are all familiar. Two years ago at this meeting we heard two papers presented by the directing heads of two large wheat-growing establishments, each of which reported a cost of production below 50 cents a bushel. In another instance which has come to my attention since that time, a man who is directing the farming of 25,000 acres in Iowa stated that he could make a profit on wheat at 50 cents a bushel.

Just at the present time the largest work of the professional farm manager is in these grain growing regions, where the reorganization of agriculture is now in progress. The unwilling owners of many million acres of farm land in all the western states will have to rely largely on the professional farm manager for the solution of the important financial problem which now confronts these owners.

In the regions of small farms, where modern machinery cannot be utilized to full advantage, the problem of reorganization is more difficult, and will doubtless take more time. The services of the agricultural engineer are highly important here. To accomplish the reorganization successfully in these regions we shall need serious and extended research programs. Experience with large-scale farming in these regions is almost lacking; we have much to learn before we shall be able to bring together a number of adjacent small farms into a unit of sufficient size to permit the greatest possible economy in production. In this work the services of the professional farm manager must constitute a major element. We must also have the help of research ability of the highest order.

The reorganization of small farms into large units, in many cases large family farms, is only one of the means necessary to profitable agriculture. In addition we must have wise selection of crops, wise decisions as to the relative acreage of these crops in the farm organization, and the use of all the latest information as to agronomic methods in order that yield per acre may be maintained at the highest possible level. There must also be research work on the animal enterprises conducted in large units. The professional manager as well as the agricultural engineer, must be an important factor in this research.

SUMMARY

To summarize briefly the relation of the farm manager to the reorganization of agriculture which must be accomplished in order to mitigate the effects of the present depression; the professional farm manager must familiarize himself with the experience of large-scale operators wherever such experience exists, both on large family farms and large corporation farms. He must acquire the latest information on such subjects as crop rotation, crop adaptability, and crop utilization. He must learn how to maintain yields at a high level. By the success of the work he undertakes and by the high degree of professional ethics which he must maintain in order to succeed, he must win the confidence of land owners in order to secure the opportunity to do the work he is capable of doing in the present scheme of things. If he is finally able to demonstrate that he can manage suitable farm properties in such manner as to make them profitable to the owners, he can then establish confidence on the part of investors that will enable him to direct the investment of large sums, and then to direct the operation of the enterprises in which the investments are made.

The agricultural engineer must work out many problems relating to new machinery, reduction of costs through labor-saving devices, and the like.

In those sections where the topography or other conditions make it impracticable to organize agriculture in such a way as to permit the use of large modern labor-saving machinery, it would appear that agriculture, if it maintains itself, must go to the self-sufficing basis. In other words, it must become subsistence farming, of the kind that prevailed east of the Allegheny Mountains before the railroads had penetrated the Middle West.

The present situation in Russia calls for a word of comment. If the five-year plan for agriculture succeeds, Russia will soon be able to dump onto the world's markets a quantity of wheat greater than the present export of any country. She can do this regardless of cost of production, which, on their largest farm, was last year 74 cents a bushel. If Russia pursues this policy, and thus demoralizes the agriculture of the entire world, the western nations will have no recourse except to prohibit Russian imports. But if Russia sells her wheat at a profit, and ceases to expand her acreage when this profit disappears, then the rest of the world can take chances of competition with her, and no drastic measures will be necessary.

Heat Sterilization in Milk Control[1]

By James D. Brew[2]

ANY discussion of the efficiency of sterilization as applied in the field of bacteriology must take into consideration the question of death rates, even when one may be attempting to present a paper purely from the so-called practical point of view. To the bacteriologist, sterilization in a milk plant, and especially on the dairy farm, presents so many inherent difficulties that in a discussion of this nature it is necessary to understand terms. "Sterilization" means to kill all bacteria irrespective of the method employed. Under the conditions that exist, however, at the farm dairy or in the milk plant it is safe to say that a total elimination of bacteria is rarely, if ever, accomplished.

What literally happens under what we call efficient plant methods is to eliminate most of the bacterial life from the surface of utensils or of milk plant equipment. This, more strictly speaking, instead of being sterilization is to the bacteriologist, "disinfection"—a term which includes any method designed to eliminate most bacteria, especially all undesirable bacterial life, including in particular the pathogenic. To most laymen the term "disinfection" or "disinfectant" implies chemical methods. It is somewhat difficult for most of us to think in terms of "disinfecting" dairy utensils. "Sterilization" in the dairy sounds better than "disinfection." Since our aim in sanitary milk control is to eliminate bacteria, even though this is not always easy to do, there perhaps can be no serious objection to continuing this discussion under the title of "heat sterilization," so long as we keep in mind its limitations.

The theories that have been advanced to explain what takes place in chemical disinfection or sterilization are not entirely satisfactory. It is not easy to see what takes place inside of a cell as small as a bacterium. Some of the chemical substances undoubtedly diffuse into the bacterial cell and coagulate the protoplasm; others combine chemically and exert a toxic effect; others destroy, or at least inhibit, bacterial growth by virtue of differences in tonicity or differences between the specific gravity of the moisture content of the cell and that of the surrounding medium, bringing about a collapse of the protoplasmic contents called plasmolysis, or in case of an inward diffusion of water, a rupturing of the cell wall called plasmotysis. The bacterial cell may be completely destroyed by strong acids or oxidizing agents.

EFFECT OF HEAT

When heat is applied to the cell the rate of action is different, depending upon whether the heat applied is moist or dry. In either case the death rate is determined and complicated by a number of factors. The layman operating a dairy or a milk plant oftentimes becomes impatient because a given sterilizing procedure does not apply with equal efficiency in all cases. It seems difficult for him to understand that there exists variability in resistance to unfavorable conditions among bacteria as among the human race, for instance.

A famine might conceivably be so devastating as to completely depopulate a given area. It can be readily understood how, at the onset of the famine, the death rate, though higher than normal, would be relatively low as compared to later periods. The weaker individuals naturally die off first, the more hardy or more resistant individuals continuing to survive. Ultimately, however, a period would come in the course of this devastating famine where the death rate would be so high as to result in a comparatively sharp drop in the curve. Even then for various reasons some individuals would continue to survive and the death rate curve usually flattens out. If the famine was sufficiently devastating, every individual would ultimately disappear. If not, a few, at least, would survive to perpetuate the group.

A catastrophe might be of such proportions as to kill off an entire group instantly or within a relatively short time, or it may be so slow in its operation as to result in a longer drawn out death curve. In our bacteriological laboratories we employ methods that act both ways.

Ordinarily in the field of sanitary milk control it is not feasible or economic to employ sterilizing procedures that operate with as great a degree of efficiency as can be employed in the bacteriological laboratory. The installation of equipment that would be necessary to accomplish equally as efficient sterilization in a milk plant would be prohibitive in cost. Much of our dairy machinery is large, heavy and immovable, such as a large pasteurization outfit, for example, and cannot be placed in an autoclave. Furthermore, there would be little gained, even from a sanitary point of view, to attempt to institute procedures to eliminate all bacteria from milk if such a thing were possible.

ABSOLUTE STERILIZATION UNNECESSARY

What we are particularly concerned about is to institute procedures that are applicable to the elimination of all pathogenic microorganisms and the great majority of non-pathogenic microorganisms that cause milk to spoil if given an opportunity to grow. It is a comparatively easy matter to accomplish this anywhere under practical conditions. The cost need not be prohibitive, but to insist upon absolute sterilization would be more costly than market conditions would warrant and would, in addition, be extremely difficult because the employees in milk plants or on dairy farms are not trained bacteriological technicians.

Killing microorganisms by heat is primarily a function of the relation of time to temperature. A prolonged application of moderately high temperatures may accomplish the same purpose as high ones briefly applied. Therefore, it is impossible to state specifically just what sterilizing temperature should be employed.

The most plausible theories advanced to explain the action of heat as a killing agent are as follows: Where lower temperatures are employed over a relatively long period of time, the "building up" or anabolic processes are slower than "tearing down" or katabolic processes. This leads to a gradual weakening or attenuation of the bacterial cell and ultimately results in death of all except possibly the more resistant cells.

Higher temperatures result in either a coagulation of the protoplasm or, if sufficiently high, in actual burning.

Heat may be applied dry or moist, but there is considerable difference in the way in which each method acts. For example, as reported by Zinsser, anthrax spores killed in one to twelve minutes, by boiling at 100 C (degrees centigrade), required three hours at 140 C dry heat. This difference in the two methods is undoubtedly a moisture relationship as indicated by the following results taken from Zinsser's textbook on bacteriology:

1. An aqueous solution of egg albumin coagulated at 56 C (133 F [degrees Fahrenheit])
2. Egg albumin with 25 per cent water coagulated at 74-80 C (176 F)

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[1]Paper presented before the meeting of the North Atlantic Section of the American Society of Agricultural Engineers, Rochester, New York, October, 1930.

[2]Milk specialist, bureau of milk sanitation, New York State Department of Health.

3. Egg albumin with 6 per cent water coagulated at 145 C (293 F)
4. Anhydrous egg albumin was not coagulated at 170 C (386 F).

Undoubtedly bacteria exposed to moist air absorb some water and therefore become more easily coagulable. Spore-forming bacteria are the bane of the bacteriologist's life in attempting to sterilize his equipment. Spores are known to contain less moisture, and this undoubtedly explains their extreme resistance to ordinary sterilizing procedures; and to insure efficiency it is necessary as a margin of safety to sterilize for several minutes under a steam pressure of 15 pounds, which, as is well known, makes it possible to obtain temperatures of about 120 C, or 248 F.

These reasons are sufficient to explain why moist heat will undoubtedly always be used in the dairy or milk plant. Some have tried dry air sterilization, but so far as I am aware the results have never been published.[3] While sterilization under pressure is done in a few plants, yet the process is too expensive under most conditions. We must give our attention to the degree of efficiency attainable at lower temperatures and here is where we meet with some factors that prove somewhat disconcerting.

Numerous factors operate to complicate efficiency in heat sterilization, especially where lower temperatures are employed. Yet, if some of the fundamental principles could be impressed upon the dairyman, he could attain an acceptably high degree of efficiency with comparatively little effort and expense. Instead of thinking in terms of absolute efficiency, it is safer for us to think in terms of degrees of efficiency. If a man can eliminate by one meth ed more than 99 per cent of the microorganisms, that method is more efficient than another that eliminates only 60 per cent.

As previously stated, efficiency in sterilization is primarily a function of time and temperature relationships. This can be made clearer by citing the following statement made by Dr. Rahn of Cornell based upon his own observations in the laboratory and upon a resume' of the literature: "The miscellaneous microorganisms that are killed in 30 minutes exposure at 144 F are killed in 3 minutes at 163 F and are killed at 180 F in less than one minute." Some species of microorganisms are so heat resistant, however, as to be little affected by these short exposures, even at the higher temperatures. If this one point could be impressed upon everyone who attempts to clean any utensil, there would be much more efficient sterilization done. Most men in a milk plant are governed entirely by "how hot" water feels.

Another point which one should always keep in mind, especially in handling dairy utensils and milk plant equipment, is a fundamentally important one. That is that different microorganisms vary widely in the optimum temperatures at which they will thrive best. Growth is retarded at temperatures lower than the optimum and practically ceases where the temperature is sufficiently low. Likewise, growth is quickly retarded at temperatures even slightly above the optimum, and, if the excessive temperature is continued, death ultimately results.

In general terms it may be stated that the optimum temperature at which most of the miscellaneous microorganisms in milk grow best ranges from about 65 to 100 F. Hence temperatures even no higher than 115 to 120 F gradually result in the killing of some bacteria. However, all bacterial cells in any given mass of organisms are by no means alike. There is considerable variation in the resistance of different cells and normally temperatures as low as 120 F have little effect, if any, on the more resistant types.

Another complicating factor must also be taken into consideration, and that is the ease of killing any given mass of organisms may be influenced by the stage of growth. Organisms, when placed in a medium favorable to growth, first pass through a "lag phase". This is early in the process of growth, and during this phase the bacterial cells possess a considerable degree of resistance. Under unfavorable conditions this "lag phase" may last a long time. The second phase is known as the "logarithmic growth phase." It is during this phase that growth takes place most rapidly and microorganisms are most easily killed. The number of resistant cells is at a minimum during this phase. This is an important factor in the efficient pasteurization of milk. As applied to the sterilization of utensils, however, the conditions in utensils are more apt to be unfavorable to bacterial development and therefore tend to force many of the organisms into the more resistant stages. Hence it is safe to conclude that 120 F exposure has little significant effect in sterilizing utensils. Yet many dairymen tell us that they sterilize in water "hot enough to bear the hands in," which is rarely above 120 F.

Sterilization of dairy utensils and equipment is complicated by two other factors, and these are the ever-present danger of becoming excessively contaminated with spore-producing organisms or by excessive accumulations of microorganisms classed as thermophils. There are a number of species included in the latter group, and one of the outstanding characteristics of this group is that, instead of being killed within 30 minutes at 144 F, they

[3]EDITOR'S NOTE: Results of research work in dry-air sterilization of dairy utensils, conducted by A. W. Farrall at the California Agricultural Experiment Station, were published in AGRICULTURAL ENGINEERING for December 1927 (Vol. 8, No. 12), also in the 1928 Transactions of the American Society of Agricultural Engineers.

Growth of microorganisms is retarded at temperatures lower than the optimum and practically ceases where the temperature is sufficiently low. In this fact lies the value of refrigeration

may grow readily in the pasteurizer, and if the milk is held long enough at this temperature, it may become sufficiently high in acid to curdle.

The optimum growing temperature of these organisms is considerably higher than the average types normally present in milk and constitutes a serious potential menace, especially in pasteurizing plants. They require a correspondingly higher temperature in order to kill them. No milk plant manager can know anything about the relative number of resistant microorganisms or spore producers in comparison to the number of non-resistant types. To be on the safe side he must assume that the resistant types are always present and consistently make use of more strenuous procedures to insure the elimination of all microorganisms down to an irreducible minimum at least. This demands two steps, first, efficient cleaning mechanically, and, second, the employment of higher temperatures efficiently applied to make certain that the utensil in question is properly heated.

A resume' of the literature shows widely variable results in what we call thermal death points. In fact, so variable are the results that one approaches this part of the discussion with considerable hesitancy. I shall not attempt a discussion of the possible factors that contribute to many of the variable results reported. Referring again to Dr. Rahn's statement, it can in general be safely stated that a momentary heating of every square inch of utensil surface to temperatures at least above 180 F will eliminate the vast percentage of bacterial life. In fact, an exposure of no longer than one minute at or above 180 F can be depended upon to eliminate practically all vegetative forms of bacteria. There will, in fact, be left on the surfaces of such utensils mostly spores and perhaps a few of the more extreme heat-resistant vegetative or growing cells. These can be controlled by preceding the sterilization with a thorough cleaning in warm alkaline solution.

Lack of appreciation of these fundamental principles, of course, explains many failures, even in plants that are equipped for proper steam sterilization. Frequently milk bottle sterilizers are found which are operated so poorly that the bottles are exposed only to dense clouds of steam, and it is very frequently possible to handle the bottles so "sterilized" with the bare hands immediately after removal from the sterilizer. It is safe to say that, for all practical purposes, a utensil to be efficiently sterilized should be at least heated so that it is too hot to handle with the bare hands. This is a rough measure and no one knows how hot such a utensil must be before it becomes "too hot to handle."

The elimination of microorganisms from dairy utensils and equipment to a very high degree of efficiency is much simpler than many suppose.

Even the simple process of rinsing mechanically removes large numbers of microorganisms. Prucha, in Illinois Bulletin 230, reports that 3 quarts of clean water at 70 F will wash out 85 to 90 per cent of the bacterial content of a milk can. Using 3 quarts of water at 150 F increases the efficiency to upwards of 95 per cent, and using water at 200 F to upwards of 95 to 98 per cent. Hence, it would be well for every dairyman to thoroughly rinse every utensil immediately before using, preferably with boiling hot water; but lacking the latter, the use of cold water would help considerably. This simple procedure illustrates the fact that maintaining a satisfactory bacterial control so far as numbers are concerned is not so difficult, and that there is little or no excuse for utensils being so poorly cleaned that when any milk is put into them large numbers of bacteria are added per cubic centimeter.

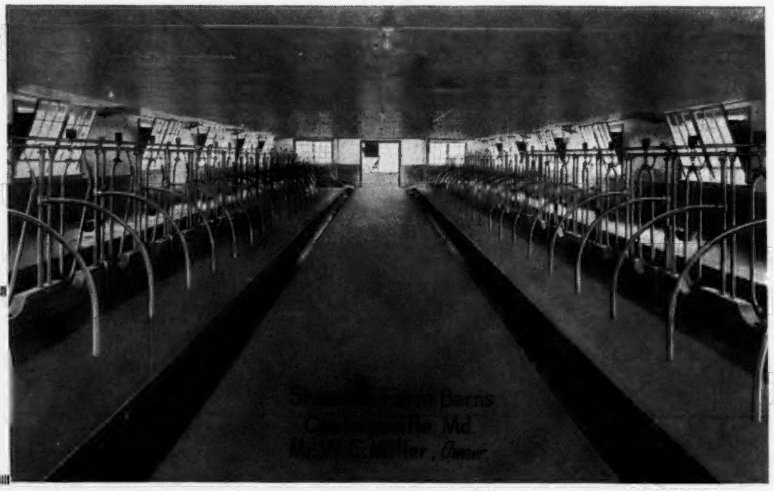
Table I. Bacteria Surviving the Action of Commercial Cleaner Solutions for Various Periods of Holding at 48.8 C (120 F)

Time, min.	Concentration of Alkali			
	0.5%	0.7%	1.0%	2.0%
	pH 10.8	pH 11.0	pH 11.2	pH 11.6
0	4,000,000	4,000,000	4,000,000	4,000,000
1	30,000	20,000	600	200
2	25,000	10,000	400	80
3	15,000	5,000	250	0
4	10,000	3,000	150	0
5	5,000	2,000	50	0

Recent investigational work done on the efficiency of some commercial cleaning compounds reveals the fact that all of them play an important part in efficient cleaning and even in sterilizing. Some are considerably more efficient than others. Some possess greater germicidal action at lower concentrations than others. Some, in fact, possess sufficient germicidal properties to completely sterilize even in comparatively cold solutions, but the efficiency of any cleaning compound in solution, even of the so-called weeker compound, is enhanced by higher temperatures.

Mudge and Lawler published some highly instructive and interesting results in the "Journal of Industrial and Engineering Chemistry," April 1928. Part of this report related to studies on the use of the stronger alkaline solutions as used on milk bottles. They also report on "One of the More Popular Dairy Cleaners." It is unfortunate that the name is not given, but this cleaner consisted of a mixture of sodium hydroxide and sodium carbonate and the results show the importance of the concentration of this alkali as a germicide at the same temperature. These results are given in Table I taken directly from their report, with slight modification.

The stronger washing solutions are clearly more germicidal than the weaker at the same temperatures. This fact has been generally recognized by every one, but this table gives us some idea of the concentrations that are most effective. It would not be safe to assume that the results in this table apply to all cleaning compounds. Furthermore, too strong alkaline solutions may corrode certain metals and care must therefore be exercised in



A clean stable is an important beginning in milk sanitation but it is impossible to keep all pathogenic and other objectionable microorganisms out of milk. Frequent careful sterilization of milk handling equipment is therefore necessary

Table II. Bacteria Surviving the Action of 0.5 per cent Alkali for Various Holding Periods at Temperatures Indicated

Time, min.	Temperature in Degrees Fahrenheit			
	100	110	120	140
0	400,000	400,000	400,000	400,000
1	4,000	1,500	500	200
2	2,000	750	400	150
3	1,500	500	300	50
4	1,000	300	100	40
5	750	200	50	10

using them. What is needed is a study of the common alkaline cleansers bringing out just these points, and in publishing the results the trade name of each cleanser should be used. The marked germicidal properties of this particular cleaning compound is of real interest, and we are doubtless safe in assuming that many of the cleansers on the market today (especially those made up partly of sodium hydroxide) can be depended upon to sterilize in a very short time in a concentration of 2.0 per cent. Where such a concentration appears to be too strong as evidenced by injury to the hands or to metal, effective sterilization by weaker solutions can be gotten by longer exposure, or by increasing the temperature which is undoubtedly the safer procedure.

The important part that temperature plays is illustrated in Table II, which was also copied from Mudge and Lawler's report. These results show the influence of a sodium hydroxide solution of 0.5 per cent concentration used at different temperatures.

We cannot expect to have the temperature of any wash water as high as 140 F, if the individual doing the washing has to place his hands in the water. It is necessary to use water at lower temperatures. In fact, 120 F is about all any one can stand. This will bring about a marked reduction in the germ life of any utensil with some of the common commercial cleansers at concentrations as low as 1.0 per cent. Any one washing in lukewarm water, however, should bear in mind the fact that the germicidal action is lower than the same concentrations at higher temperatures. The common practice is to throw a handful or so of cleaning powder into a vat of water, and it is safe to assume that such solutions are too weak to have any measurable effect upon the germ life aside from those removed mechanically.

After all factors are taken into consideration, including the personal element, we must rely, in general, upon heat or upon hypochlorites to sterilize utensils. But there is the everpresent tendency to substitute chemical sterilization for cleanliness. Heat is conceded to be the most satisfactory of all sterilizers as applied to the dairy. The chief precaution to keep in mind is to make sure that the temperatures are sufficiently high and that the utensils be exposed to these high temperatures a sufficient length of time. The importance of sufficiently high temperatures cannot be overestimated. The miscellaneous microorganisms, as previously stated, that are killed off in 30 minutes at 144 F are killed in 3 minutes at 163 F. The death rate is a matter of several seconds at temperatures above 180 F, which is the minimum temperature specified in our state (New York) sanitary code. An exposure of one minute is, generally speaking, ample margin, especially where the utensils have been thoroughly washed. This treatment can in general be counted upon to eliminate a large percentage even of the heat-resistant forms, such as spore formers and the like.

Prucha found that to steam a well-washed can 20 seconds rendered it sufficiently well sterilized that the count per cubic centimeter in a full can of milk would be increased by only about 10 to 20 bacteria. A 100 per cent sterilization is difficult to obtain in actual practice in any dairy. The higher the temperature to which a utensil is heated, the more certain it is to dry, and the importance of drying in bacterial control cannot be overestimated. All utensils should be heated so hot that it is at least impossible to handle them with the bare hands when taken out of the steam.

Agriculture a Public Utility

HAVE you ever thought of farming for just what it is—the greatest of all public utilities? In this connection have you realized that the advance farming is to make will in large measure parallel the experience and practice of the other public utilities. This is because the success of agriculture as well as all other utilities has to do primarily with the efficient utilization of massed power.

Basicly agriculture and the other utilities are the same type of industries; having investment, production and marketing problems of almost identical nature.

Neither sells its basic property but both dedicate its use to the service of the people. Each has a long slow turnover; once in 4 to 6 years for the utilities and once in 6 to 10 years in agriculture. Each has as a maintenance problem, the upkeep of property which has a long life.

Each pays a very large proportion of its gross income in taxes, many times exceeding the profits to the owner and operator over a long period of time. Each has an efficiency or production cost which is less than the fixed and capital costs.

Each can reduce its fixed costs per unit by

(1) Operating larger units of property
(2) Operating large units of equipment
(3) Operating in order that the output per dollar invested is a maximum, in other words, operating with a better load factor.

Each has a fixed maximum for its output.

(1) Agriculture must accept a world market price.
(2) The price of utilities products are fixed by law.

Each must increase its income by taking a small profit per unit. The producer of the largest number of units per worker has the greatest income.

Each operates in a restricted market and must increase its sales.

(1) By developing new uses
(2) By developing new markets

On account of the relatively large percentage of fixed costs as compared with the variable costs, each can calculate its costs in advance under given conditions with great accuracy.

This analogy can be carried to great length as the industries follow the same basic laws.

The most vital factor in agriculture for profit is yield and it has two phases

(1) Yield per worker
(2) Yield per acre

The yield per worker is purely a function of the worker made possible only by efficient equipment properly used. The yield per acre as the size of the unit increases becomes more and more a matter of equipment.

Each factor has an almost exact parallel in the utility field and each problem of agricultural production will be solved largely as the production problems of the utilities have been solved. A vital, but far overstressed agricultural problem, as with the utilities, is sales price of the product. . . . . .

Utility practices in farming will replace the practice of curtailing the output and its accompanying increased costs by increased output with larger markets and reduced costs. They will develop in the agricultural districts factories that will not only furnish a home market for the commodities of manufacture, but will give to the farm a home market for general farm produce.

From an address entitled "A Look Ahead in Agriculture" presented by Hickman Price at the last annual meeting of the National Association of Farm Equipment Manufacturers.

A Review of Power Take-Off Standardization Work[1]

By W. Leland Zink[2]

DURING the past year the matter of more thorough standardization of the agricultural tractor and implement power take-off has received a great deal of attention. The apparent inadequacy of our former standards revised up to July 1928 may be explained by the fact that the power take-off is still a fairly new development, the adaptation and use of which has grown very rapidly. Five different power take-off committee meetings as well as several subcommittee meetings were held during the 24th annual meeting of the American Society of Agricultural Engineers at Moline in June 1930. Several committee and subcommittee meetings have been held and much individual effort has been expended on the problem since that time. Such points as types and sizes of power take-off shaft ending, spline dimensions, fitting tolerances, means of retaining the universal joint fitting to the shaft, rotating speed, power take-off shaft location, drawbar length relative to the spline shaft end, and proper safety precautions have all received careful attention. The tractor and drawn-tool manufacturers and other interests having experience with the power take-off have cooperated in this work.

We have tried to retain the basic idea or thought of the former standard wherever possible. An effort has been made to be more specific, to add to the standards where a need was apparent, and to bring in a more definite division of responsibility between the tractor and drawn-implement builders. We have tried to keep both the present day and future problems in mind. Most of all we have tried to work out a set of standards which would be sound from an engineering and manufacturing standpoint.

We have started by changing the name of the standard from **"Power Take-Off for Farm Tractors" to "Power Take-Off for Agricultural Tractors and Machines."** This change was felt necessary because of the fact that both tractor and implement power take-offs were involved. We hope this name may be further broadened in the near future to include all tractors and machines.

The tractor power take-off shaft specifications have been grouped under the first paragraph of the proposed standard. It takes in both front and rear; in fact, power take-off shafts issuing from the tractor in any direction which might be utilized for driving drawn or mounted implements while the tractor is traveling. This change was felt desirable as several front-end power take-off shafts are already in existence.

Several types of power take-off shaft ending, such as the modified taper, the flange connection, the left-hand thread, and the spline have been considered. Had we been tackling an entirely new problem, without a great amount of equipment already in service, either the modified taper or flange might have been utilized to advantage in working out a connection, whereby it would be possible to attach a small capacity driven implement to a large tractor without changing any parts. The left-hand thread seemed very unpopular because of the difficulty of removing threaded fittings from the power take-off shaft. In view of the spline type shaft having been specified in the former standard and its present wide and successful use, our committee came to an early decision to retain the spline type of shaft. The former spline dimension of 3 inches effective length has also been retained.

It has been decided to provide nominal spline diameter sizes of 1⅛, 1⅜ and 1¾ inches. About one year ago it was voted by representatives of all interested tractor and driven-implement manufacturers to discontinue the 1⅛-inch size by January 1, 1932. This decision seemed justified by the general desire to standardize where possible on the 1⅜-inch spline and thus make it possible to avoid hook-up delays. It was also felt that the elimination of the 1⅛-inch size would materially aid in reducing warehouse bundles and repair stocks. After considerable discussion over this matter at Moline, it was decided that the 1⅛-inch spline should be retained for the present at least. Since that time, however, it has been decided that a clause should be added to the proposed recommended practice which would encourage using nothing smaller than the 1⅜-inch size. This is covered by Paragraph 1 of the proposed A.S.A.E. Recommended Practice. Several large manufacturers have already decided to standardize on the 1⅜-inch spline. The 1¾-inch spline size has been added for use on very large tractors developing 60 to 100 brake horsepower. While we have not had much demand as yet for this size, it was requested that it be added at once. By doing this, it was thought that as power take-off driven implements were developed for these larger tractors, a uniform size and type of shaft might be used, thus avoiding many of the difficulties we have had in the past in connection with smaller shaft sizes.

Our former power take-off standard only mentioned that an SAE 6B spline fitting be used. The SAE Handbook, however, covers the hub dimensions only. The 6B spline is supposed to be a sliding fit when not under load. However, there are many opinions regarding proper spline fits and tolerances. It was quite natural, therefore, to find considerable complaint from the field regarding spline shaft size variations. A careful survey was made of the spline shafts in existence, the results of which showed this complaint to be warranted. Most of the manufacturers seemed to depend on locating on the large diameter of the shaft and the spline groove. Several seemed to depend on locating on the small diameter of the shaft and the spline groove which is a common practice where heat-treated hubs are used. At least one manufacturer apparently depended on locating at all three points. One or two manufacturers were using spline shaft dimensions

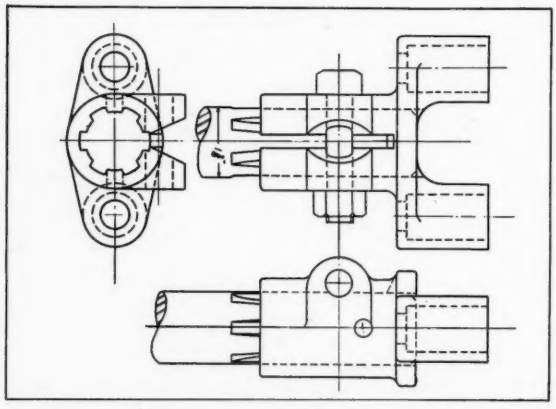


Fig. 1. Typical single bolt clamp type yoke attached to standard spline shaft using both pin and groove retainment

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1930.

[2]Chief engineer, General Implement Company, Mem. A.S.A.E. (Chairman, A.S.A.E. Committee on Power Take-off.)

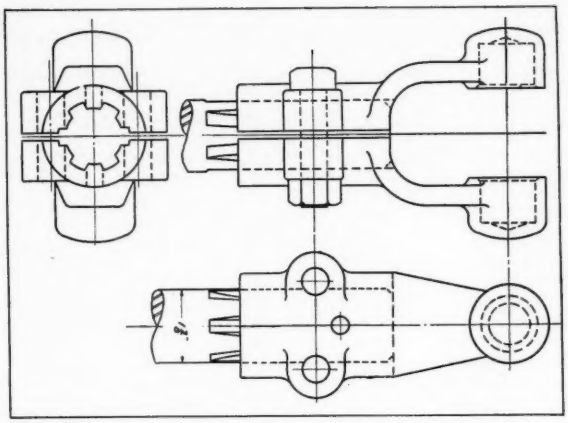


Fig. 2. Two bolt clamp, split type fork attached to standard spline shaft using both pin and groove retainment

which would require pressing or driving the fitting into place.

In view of these variations and field complaints, our committee decided to work out definite dimensions covering both the shaft and hub for the 1⅛, 1⅜, and 1¾-inch sizes. It was further decided to call these "ASAE Splines." Because of the fact that most of the agricultural implement fittings are not heat-treated, it was decided to locate the fitting by the large diameter of the shaft and the spline width. This method of location, it is felt, makes it unnecessary to hold the inner diameter of the hub to the close limits specified for the SAE 6B fitting. This explains our reason for also providing our own hub dimensions. The tables of ASAE spline shaft and hub dimensions of the proposed standard show how these details have been worked out. The large diameter clearance of the 1⅜-inch shaft and hub runs from 0.001 to 0.004 inch, while the spline width clearance runs from 0.002 to 0.006 inch. An enlargement of several of the shafts covered in our survey would actually show interference or press fits either at the large diameter dimensions or at the spline and groove widths. Similar fits and tolerances are provided for the 1⅛ and 1¾-inch shaft and hub sizes. These dimensions and tolerances have been very carefully checked not only by our committee, but by the engineering staffs of tractor and implement manufacturers, universal joint makers, and the spline and hub makers. Specific questions put to tool room foremen and inspection departments as to where broaches and hubs first wear out so as to cause inspector rejection brought out some interesting facts. It is felt that the proposed dimensions are reasonable and that the fits are close enough to give good service. Manufacturers desiring closer fits can work to narrower tolerances than specified and still be within the standard.

When we came to the matter of adopting a generally satisfactory means for retaining the universal fitting to the splined shaft, we came up against a real problem. The former standard had not fully covered this point. Formerly a hole located at a point 1 inch from the end of the shaft and of suitable size for a 3/16-inch pin was specified. This 3/16-inch pin retainment, however, had been found insufficient on the larger tractors when operating tools such as the stubble beater and combine, and had therefore been voted out. As a result of the lack of agreement on this matter, it was found that the 3/16-inch pin, the pin and clamp, the tapped shaft, and the threaded-shaft end were all being resorted to. In trying to clear up this situation it seemed agreeable to retain the 3/16-inch pin retainment provision for the 1⅛-inch shaft. The threaded shaft end providing for a washer and nut retainment was tentatively decided upon at Moline as the proper solution for the 1⅜ and 1¾-inch shaft sizes. For the threaded-shaft end and nut, a sleeve or thrust collar was also needed at the front end of the effective spline length.

After further study of this matter by various members of our committee and a great number of laboratory tests carried on by H. D. MacDonald[1], the retainment situation was carefully reconsidered. The problems of providing a sleeve or shoulder for the forward thrust, the heat-treatment of a heavy piece with an exposed thread, the difficulty of getting the proposed retaining nut in place, and the necessary extra universal fork clearance for the retaining nut and washer were all common to the threaded-shaft end. It was found by a survey of the universal joint equipment in service that not one of these joints had sufficient clearance to take care of the nut and washer. Adopting this type of retainment would have meant bringing out new joints with longer front forks and heavier yokes, and requiring more bearing overhang. The most important objection was that of moving the pivotal center of the front joint approximately 1 inch farther to the rear. In most cases this pivot point is already so far to the rear as to make drawbar extensions necessary and to cause steering difficulties. It also seemed rather impractical to use one type of retainment on one shaft and another type on the other two. Even the plain pin type of retainment seemed to have some objections.

It seemed desirable to find a simple, inexpensive type of retaining means which would eliminate as many of the above problems as possible. It was also desirable to work out something which might be suitable for use on all shaft sizes and as adaptable to present day equipment as possible. With these thoughts in mind Mr. MacDonald ran over seventy laboratory tests covering different types of retainment. His conclusion was that, if pin sizes in proportion to the horsepower capacities of the various shaft sizes were used, the pin retainment means might be adopted as sufficient in all cases.

SHAFT GROOVE FOR ADDITIONAL RETAINMENT

At a committee session on September 24 Mr. MacDonald suggested that the pin type of retainment as proposed by him be supplemented by a groove around the shaft, the groove to be somewhere in the splined section and of the same depth as the spline. This groove seemed to be an inexpensive way of providing for extra retainment. It provides for setting the hub clamp bolt or a pin into the line of the shaft for positive fore-and-aft retainment. Several groove and pin locations were discussed. Those which seemed to meet the requirements and existing conditions to the best advantage are specified in the proposed standard. Figs. 1, 2 and 3 show typical single-bolt clamp, two-bolt clamp, and solid hub type yokes being applied to this type of shaft where both the pin and groove retainment means are being utilized. Retaining a pin location 1 inch from the end of the spline shaft makes the new fittings adaptable to thousands of power take-off shafts now in service, and vice versa; the proposed spline shaft will take most of the hub fittings now in stock or service. Location of the groove at the center of the effective spline seemed desirable, especially in the two-bolt double-clamp fitting as shown in Fig. 2.

Three and one-quarter (3¼) inches was considered necessary for the purpose of giving proper clearance for universal joint and hub, as several cases of complaint were received stating this clearance had not been kept sufficient.

The former power take-off shaft speed of 536 revolutions per minute, with a tolerance plus or minus 20, was felt to give too wide a speed range, especially with such tools as corn pickers, grain binders and combines. Variations from the standard speed are causing a great deal of difficulty in the satisfactory operation of these machines by the power take-off. The range has therefore been limited to plus or minus 10 rpm.

[1]Engineering staff, International Harvester Co. Mem. A. S. A. E. (Member, A.S.A.E. Committee on Power Take-Off.)

The provision of the proposed standard covering hub dimensions has been partially explained in the foregoing discussion of shaft sizes and retainment means. No special broach will be required in producing the hub dimensions specified. The extra thousandth of an inch in limit permitted in the small diameter is the only change from the standard SAE 6B fitting. The SAE limit of only one thousandth at the small diameter was felt impractical as this portion is not to be used in locating the fitting. Regular SAE broaches, however, can be used in producing this ASAE splined hub.

RECOMMENDED PRACTICE

We found that the old recommended practice had many points in question and left some items of importance untouched. It was found necessary to expand this section from five to eleven items. Paragraph 1 of the newly proposed ASAE Recommended Practice, favoring the 1⅜-inch shaft size, has already been discussed.

Paragraph 2, covering the height of the power take-off shaft is practically unchanged. It is important that these dimensions be carefully followed, especially at the higher positions. A high power take-off shaft relative to the drawbar height causes undue telescoping action of the driveshaft members, especially when traveling over rough ground.

Paragraph 3, providing that the power take-off shaft shall extend far enough to the rear to clear the fenders and platform and that the drawbar, or an extension of it, shall extend 10 to 15 inches to the rear of the power take-off shaft end, is unchanged. It is important to carefully watch the 10 to 15-inch dimension. In fact, it would be well to narrow this limit close to the 15-inch dimension, as it is practically impossible to get in a satisfactory telescoping length and at the same time hold the hitch point midway between the two front universals with less than this amount.

Paragraph 4, on tolerance for locating the spline shaft as near to the tractor center line as possible, has been narrowed to 5 inches right or left of center. The former tolerance of 10 inches has been found excessive even on many of the common applications.

Paragraph 5 provides that a power take-off shaft of suitable length to meet the standard as specified above shall be furnished by the tractor manufacturer.

Paragraphs 6 and 7 specifically divide the shielding responsibility between the tractor and implement builder. Paragraph 6 states that the shield for the front universal joint and the power take-off shaft shall be furnished by the tractor manufacturer; it also states that this shield shall protect the operator from a standard length telescoping member. This point is especially important to minimize danger in case the telescoping members are accidentally pulled apart in operation. It is important that such a shield be made a regular part of the tractor power take-off attachment. Manufacturers of both tractor and drawn implements might insist to good advantage, through their sales and service organizations, that no hook-up be started without a satisfactory front shield in place. Most of our fatal power take-off accidents occur by the operator getting caught at the front universal joint. An occasional loss of a sale is a small matter compared to the possible danger of a serious accident. Paragraph 7 specifies that all shields required back of the front joint and parts required for hooking onto the standard power take-off shaft ending and recommended drawbar location shall be furnished by the drawn-implement manufacturer. Possibly this point should have been broadened to more specifically cover the duty of the drawn-tool builder to supply universal joint connections for the three standard sizes of spline shaft. This provision is especially important in the case of the 1⅛ and 1⅜-inch shafts.

Provision for a simple throw-out clutch for the power take-off drive is encouraged in Paragraph 8. It is important that the recommendation that this clutch be safe against accidental engagement be carefully followed. Having the control for this clutch located convenient to the operator is another important item.

Paragraph 9 emphasizes the importance of keeping the adjacent forks of the front pair of universals in the same plane. At least one manufacturer takes care of this by using telescoping members of rectangular section, making it impossible to mis-align the front pair of joints. The placing of slip clutches between the two universals adjacent to the tractor has caused considerable alignment difficulty in the past. This item now provides that, if a slip clutch is used at this location, it should be of a type to eliminate improper joint alignment. One manufacturer provides a 180-degree slip clutch for meeting this situation. This matter of keeping the front pair of joints in proper alignment is important in getting good universal joint efficiency, minimizing joint wear, and especially in delivering a uniform rotating speed to the drawn tool.

Paragraph 10 recommends that the hitch point in plain view be kept midway between the two front universal joints. This point emphasizes the need of holding the 10 to 15-inch dimension of Paragraph 3 to closer limits and as nearly as possible to the 15-inch dimension. With the tractor manufacturer holding his hitch point somewhere near 15 inches to the rear of the power take-off shaft end, it would be possible for the drawn-tool builders to locate the second joint at a certain distance to the rear of his hitch point and thus have no difficulty in getting the necessary telescope length and in holding the point of hitch midway between the two front joints.

Paragraph 11 brings up the importance of keeping the drawbar hitch and the drive shaft connecting the tractor and adjacent tool universal joint as near together as possible for the purpose of reducing the telescoping action of the drive shaft in traveling over rough ground. The drawbar can often be raised to some extent. However, on many installations the maximum drawbar height is fixed by either the weight of the tractor or the requirements of the drawn tool.

In concluding this report, I wish to emphasize again that our goal in this matter has been to work out a standard which would fit in as far as possible with our past standard, present field equipment and possible future requirements, and which would be sound from an engineering, manufacturing and service standpoint. This has been a real task but we feel that this aim has been at least partially accomplished. Possibly we have overlooked some items of importance; however, I assure you that any suggested revisions or additions offered will receive the very careful attention of our committee. I want to thank the members of the committee, the past committee chairman, and the Secretary's office for their splendid cooperation in this project.

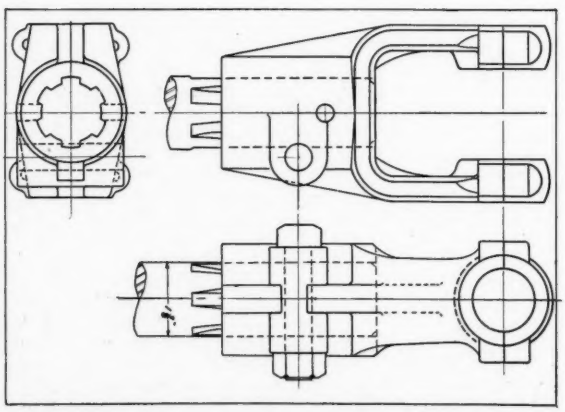


Fig. 3. Solid hub type fork attached to standard spline shaft using both pin and groove retainment

Proposed A.S.A.E. Standard

Power Take-Off

For Agricultural Tractors and Machines

Foreword

THE American Society of Agricultural Engineers has endeavored to keep abreast of the need — in the development and application of the power take-off drive to agricultural equipment — for suitable standards of design and practice to facilitate the solution of such engineering, manufacturing and application problems as are involved in the use of this device. The first standard and recommended practice covering the power take-off proposed by the Society was drafted at a conference of engineers representing tractor manufacturers held in Chicago, December 14, 1926. This first draft was submitted to the interested tractor and implement manufacturers, some minor revisions were made, and it was formally adopted by the Society in April 1927. Further revisions in the standard were adopted in July 1928.

During the period of December 1929 to December 1930 the Subcommittee on Power Take-Off of the ASAE Standards Committee held an extended series of conferences for the purpose of making an intensive study of power take-off requirements in the light of developments up-to-date, and with a view to revising the ASAE standard and recommended practice to more effectively meet present day needs. These conferences were supplemented by a large number of laboratory tests covering strength of materials and retainment means. As a result of its painstaking work during 1930, the special subcommittee feels, as expressed by its chairman, that "it has developed a standard and recommended practice which fits in as far as possible with the old standard, with present field equipment and with possible future requirements, and which is sound from an engineering, manufacturing and service standpoint."

The proposed standard and recommended practice, it is believed, will be generally approved by both users and manufacturers of tractors and implements using the power take-off. It has already been approved by leading engineers in this industry and by the ASAE Standards Committee, and is now being submitted to the voting membership of the American Society of Agricultural Engineers for approval and adoption as an ASAE Standard and Recommended Practice. Suggestions for revisions or additions to this standard will be given careful consideration by the Standards Committee from time to time in order that it may be revised and kept up-to-date as this particular development progresses.

The **tractor power take-off shaft**, except belt pulley shafts, for all types of power take-off drives issuing from the tractor in any direction shall

1. Be provided to take an ASAE spline hub
2. Have an effective length at the root of the spline of 3 in.
3. Have a nominal diameter of 1⅛ in., 1⅜ in., or 1¾ in.
4. Have the following spline dimensions and tolerances (expressed in inches):

Nom. diam.	Large Diam. max.	Large Diam. min.	Small Diam. max.	Small Diam. min.	Spline Width max.	Spline Width min.	Radius at root max.
1⅛	1.123	1.121	0.932	0.922	0.277	0.275	0.010
1⅜	1.373	1.371	1.145	1.135	0.340	0.338	0.010
1¾	1.747	1.745	1.454	1.444	0.433	0.431	0.015

5. Be provided with (as retaining means) a hole through the shaft at the root of the spline and a groove around the shaft in accordance with the following specifications (expressed in inches):

	Hole		Groove		
Shaft size	Dist. from shaft end	Diam.	Dist. of groove center from shaft end	Side radius	Minimum diam.
1⅛	1	13/64	1½	17/64	15/16
1⅜	1	21/64	1½	17/64	1 5/32
1¾	1	25/64	1½	21/64	1 15/32

6. Have a minimum clearance of 3¼ in. between the end of the spline shaft and any stationary part of the tractor. (The 3¼-in. dimension to be taken on a spherical radius from the center line of the spline shaft end.)

The **normal speed** of the power take-off shaft shall be 536 rpm—plus or minus 10 rpm—the direction of rotation to be clockwise when facing in the direction in which the tractor travels. (This applies only to fore-and-aft power take-off shafts.)

The **implement power take-off fitting** shall

1. Be provided with an ASAE spline hub, having the following spline dimensions (expressed in inches):

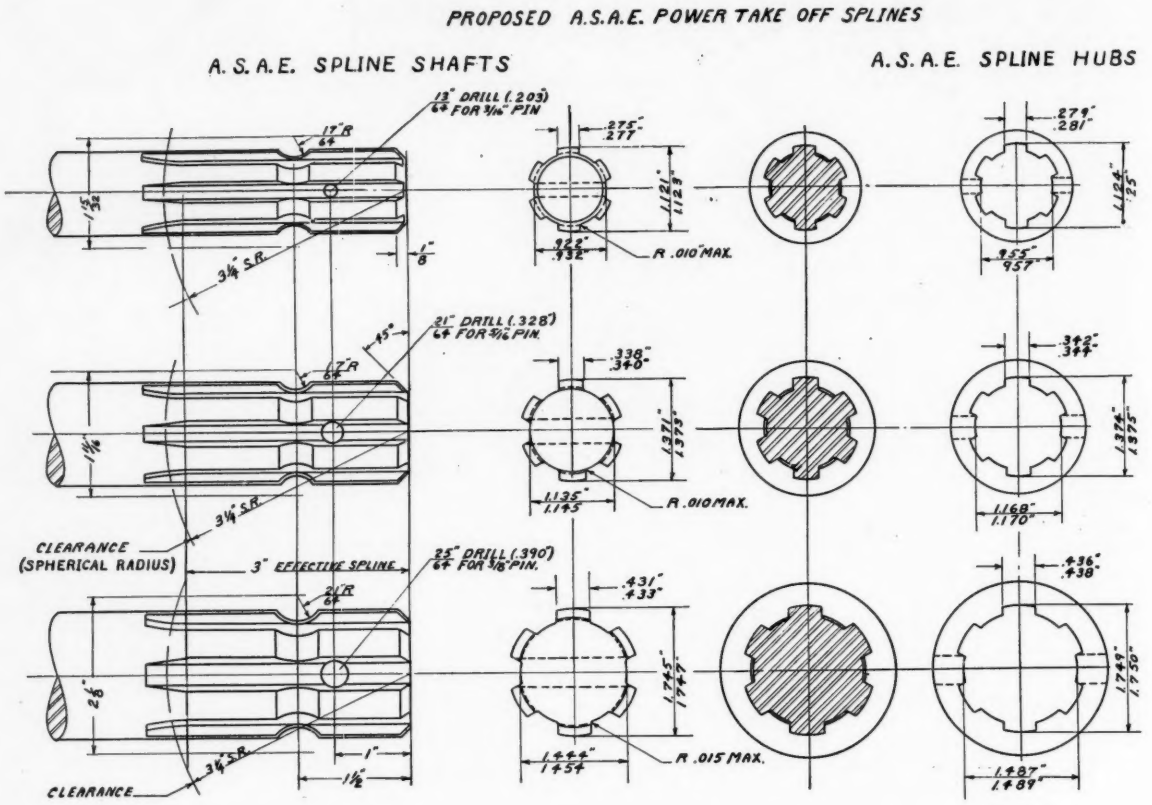
Nom. diam.	Large Diam. max.	Large Diam. min.	Small Diam. max.	Small Diam. min.	Spline Width max.	Spline Width min.
1⅛	1.125	1.124	0.957	0.955	0.281	0.279
1⅜	1.375	1.374	1.170	1.168	0.344	0.342
1¾	1.750	1.749	1.489	1.487	0.438	0.436

(The regular SAE 6B broaches can be used on the above)

2. Be provided with a hub length of 3 in.
3. Be provided for retainment to the shaft by drilling retaining pin holes through the small diameter of the spline at a point 2 in. from the tractor end of the hub as follows:

   1⅛-in. Hub — 13/64(0.203)-in. hole
   1⅜-in. Hub — 21/64(0.328)-in. hole
   1¾-in. Hub — 25/64(0.390)-in. hole

   (The spline shaft groove is provided for use where additional retaining means is desired.)



Proposed A.S.A.E. Recommended Practice

Power Take-Off

For Agricultural Tractors and Machines

1. The 1⅜-in. shaft is recommended as desirable for future design, where practicable.

2. The end of the power take-off shaft on the tractor shall be 25 in.—plus or minus 5 in.—above the ground line. (Measurements to be taken less lug equipment.)

3. The power take-off shaft, or an extension thereof, shall extend far enough to the rear of the tractor to clear the fenders and platform, and the hitch point of the drawbar shall be 10 to 15 in. back from the end of the splined portion of the shaft.

4. The horizontal location of the power take-off shaft shall be as near the tractor center line as possible. (Tolerance: 5 in. right or left of center.)

5. The tractor manufacturer shall furnish the standard power take-off shaft.

6. The tractor manufacturer shall adequately shield the power take-off shaft and tractor universal joint, and provide protection for the operator against the telescoping member attached thereto, assuming connection between tractor and implement is according to recommended practice.

7. The manufacturer of a power take-off driven machine shall furnish the power drive parts up to the tractor spline shaft, the necessary hitch parts to attach to the recommended drawbar location, and all shields, except the one attached to the tractor, covering the spline shaft fitting or universal joint.

8. The tractor power take-off drive shall be provided with a throw-out clutch, operating independently of the tractor travel, of a design safe against accidental engagement, and with a control located conveniently to the operator.

9. The telescoping members of the power shaft shall be so arranged that the tractor universal joint and the adjacent implement universal joint cannot be placed in improper relationship. (The tractor universal joint is in correct relationship to the adjacent implement universal joint when the two shaft yokes are in the same plane.) Slip clutches, if placed between these joints, should be designed to obviate improper alignment.

10. In plan view the tractor drawbar hitch point should be located midway between pivotal centers of the tractor universal joint and the adjacent driven implement universal joint, where the driven implement is being driven in normal working position. (The object of this location is to equalize universal joint angularity when turning.)

11. In side elevation the tractor drawbar hitch should be as close as practicable to the drive shaft connecting the tractor universal joint and the adjacent driven implement universal joint, the object being to reduce the telescoping of the drive shaft to a minimum in traveling over rough ground.

Proposed A.S.A.E. Standard

Disk Blades

For Disk Plows, Harrows, Drills, Listers and Cultivators

Foreword

THE standardization of disk blades for agricultural implements was originally undertaken at a conference implement and disk blade manufacturers in Chicago, November 28, 1927, called by the Standards Committee of the American Society of Agricultural Engineers. Throughout the development of this project it has had the wholehearted support of both manufacturing groups. Following the conference the first draft of the proposed standard was submitted to those who attended the conference, and later to all the manufacturers of disk blades and to practically all the manufacturers of farm equipment in which these blades are used. Minor changes were suggested, incorporated and approved by the two groups directly interested.

The original draft specified the "U. S. Standard" as the standard gage, the use of which was strongly urged by one of the leading disk blade manufacturers. However, the representatives of two of the leading implement manufacturers held that the proposed standard should specify use of the Birmingham gage, inasmuch as it is quite generally accepted as standard in the implement industry. In view of the fact that the whole problem of standardizing wire and sheet metal gages is now being studied by a sectional committee of the American Standards Association, and also inasmuch as there seems to be a distinct tendency to express wire and sheet metal thicknesses in decimals of an inch instead of by a gage number, it was finally agreed, pending the outcome of the ASA project, to accept the Birmingham gage as standard, since it is in general use at present in the agricultural implement industry.

The proposed ASAE Standard for Disk Blades, as presented here, has been approved by the manufacturers of disk blades and practically all manufacturers of farm implements using disks, and by the ASAE Standards Committee, and is now being submitted to the voting membership of the American Society of Agricultural Engineers for approval and final adoption as an ASAE Standard. Minor revisions in the proposed standard, mostly in the nature of additions, have recently been submitted and will at the earliest opportunity be studied and considered for adoption later. In fact, suggested changes and additions will be considered from time to time as revisions seem necessary to keep this standard up-to-date.

Standard Gage

The Birmingham gage shall be the accepted standard for designating the gages of all disk blades used in agricultural implements. Following is a list of gages, and their equivalents expressed in decimals of an inch, in common use for agricultural disk blades:

No.	14 gage	— 0.083 in.
No.	13 "	— 0.095 "
No.	12 "	— 0.109 "
No.	11 "	— 0.120 "
No.	10 "	— 0.134 "
No.	9 "	— 0.148 "
No.	8 "	— 0.165 "
No.	7 "	— 0.180 "
No.	5 "	— 0.220 "
No.	3 "	— 0.259 "
No.	0 "	— 0.340 "
No.	000 "	— 0.425 "

Tolerance on Thickness

Tolerances on the thickness of disk blades shall be

Nos. 14 and 13	gage	— ± 0.005 in.
Nos. 12, 11 and 10	"	— ± 0.006 "
Nos. 9, 8 and 7	"	— ± 0.007 "
Nos. 5, 3, 0 and 000	"	— ± 0.010 "

Nomenclature

Inasmuch as it is in line with best engineering practice the term "gage" (not "gauge") shall be the accepted standard.

The new type of disk plow (variously known as the "wheatland plow," "cylinder disk plow," "one-way disk plow," etc.) shall be designated by the term "vertical disk plow."

The original type of disk plow shall be designated by the term "standard disk plow."

Polishing of Disks

Disk blades for **disk harrows** shall be ground and polished the width of the back bevel only. (The inside of harrow disks shall be polished only where necessary.)

Disk blades for **standard disk plows** shall be ground and polished the width of the back bevel, and polished on the inside of the disk.

Disk blades for **vertical disk plows** shall be ground and polished the width of the back bevel. (Polishing the inside of the disk shall be optional with the manufacturer.)

Bevel on Disks

The 8-degree bevel shall be used on disks of No. 14 to No. 5 gage, and the 11-degree bevel on disks of No. 3 to No. 000 gage. (The oval bevel, ¾-inch radius, and chisel edge, having been discontinued by practically all manufacturers, are not recommended.)

Concavity of Disk Blades

1. For Disk Harrows:

16-in. disk — 1½-in. cancavity — 22 5/64-in. radius
18-in. disk — 1¾-in. concavity — 24 1/64-in. radius
20-in. disk — 2-in. concavity — 26 -in. radius

2. For Vertical Disk Plows:

20-in. disk — 2½-in. concavity — 21¼-in. radius
20-in. disk — 2⅞-in. concavity — 18⅞-in. radius (for special conditions only)

3. For Standard Disk Plows:

20-in. disk — 2½-in. concavity — 21¼-in. radius
20-in. disk — 2⅞-in. concavity — 18⅞-in. radius
22-in. disk — 2½-in. concavity — 25 7/16-in. radius
23-in. disk — 3½-in. concavity — 20 41/64-in. radius
24-in. disk — 3⅜-in. concavity — 30½-in. radius in center; 17-in. radius on outside

*24-in. disk — 3 11/16-in. concavity — 21⅜-in. radius
26-in. disk — 3¾ -in. concavity — 24 7/16-in. radius
*26-in. disk — 4 -in. concavity — 23⅛-in. radius
26-in. disk — 4½ -in. concavity — 21 1/32-in. radius

(NOTE: The asterisk (*) denotes the sizes used by the larger number of disk plow manufacturers.)

4. For Grain Drills:

13-inch disk — ¾-inch concavity — 28 17/32-inch radius

5. For Listers and Sled and Bean Cultivators:

10-in. disk — 1⅛ -in. concavity — 11 43/64-in. radius
11-in. disk — 1 3/16-in. concavity — 13 21/64-in. radius
12-in. disk — 1 5/16-in. concavity — 14⅜ -in. radius
14-in. disk — 1 5/16-in. concavity — 19 21/64-in. radius

6. For Covering Disks:

10-in. disk — ¾-in. concavity — 17-in. radius
12-in. disk — 13/16-in. concavity — 22½-in. radius
14-in. disk — 1 1/16-in. concavity — 23 19/32-in. radius

Tolerances on Concavities of Disks

(a) 10 to 14-in. disks — ± 1/16-in.
(b) 14 to 20-in. disks — ± 3/32-in.
(c) Over 20 in. — ± ⅛-in.

Tolerances on Diameters of Disks

Up to 20-in. diameter (with concavity of 2-in.) — ± 3/16-in.
20 in. in diameter and over (with concavity of more than 2-in.) — ± ¼-in.

Tolerances on Run-Out of Disks

Disks up to 14-in. diameter — ± 1/16 in.
Disks over 16 in. in diamter — ± ⅛ in.

Recommended Gages

1. For Cultivator Disks:

10-12-in. disks — No. 13 gage (not heat-treated)
13-in. disks — No. 12 gage (not heat-treated)
14-in. disks — No. 11 gage (not heat-treated)

2. For Grain Drill Disks:

13-in. disks — No. 12 gage (not heat-treated) — No. 13 gage (heat-treated)

3. For Harrow Disks:

16-in. disks — No. 11 gage (not heat-treated) — No. 12 gage (heat-treated)
18-in. disks — No. 10 gage (not heat-treated) — No. 11 gage (heat-treated)
20-in. disks — No. 9 gage, (not heat-treated) — No. 10 gage (heat-treated)
20-in. disks — No. 7 gage (not heat-treated) — No. 9 gage (heat-treated) (Extra heavy cover crop duty)

4. For Vertical Disk Plow Disks:

20-in. disks — No. 9 gage (heat-treated)
20-in disks — No. 7 gage (heat-treated) (For rocky soil conditions)

5. For Standard Disk Plow Disks:

20-in. disks — No. 7 gage (not heat-treated) — No. 9 gage (heat-treated)
22-in. disks — No. 7 gage (not heat-treated) — No. 8 gage (heat-treated)
24-in. disks — No. 7 gage *(not heat-treated) — No. 7 gage (heat-treated)
26-in. disks — No. 7 gage *(not heat-treated) — No. 7 gage (heat-treated)

(*Generally too light for heavy-duty, high-speed tractor service)

6. For Extra Heavy Plow Disks:

24-in. disks — No. 0 gage (not heat-treated) — No. 3 gage (heat-treated)
26-in. disks — No. 000 gage (not heat-treated) — No. 3 gage (heat-treated)

Center Holes in Harrow Disks

15/16-in. hole for ⅞-in. square rod (for horse-drawn harrows)
1 1/16-in. hole for 1-in. square rod (for tractor-drawn harrows)
1 3/16-in. hole for 1⅛-in. square rod (for tractor-drawn harrows)

Scientific Testing of Materials

ONE important element in our modern civilized life is the fact that today we have available many materials whose strength can be predicted and controlled. The builders of the ancient world had to take materials as they found them in nature. . . . .

Not only are we all vitally concerned with our physical safety, we are also greatly concerned with the cost of living — the cost of clothing, of household goods, of farm implements, with the amount of the taxes we must pay to keep up sewer systems, pavements, water works. Now a very large factor in determining these costs is the wisdom used in selecting suitable materials, materials whose money cost, strength, and durability are well balanced. . . .

The development of the science of testing materials is a comparatively recent thing. Perhaps the first systematic testing of materials was done some two and a half centuries ago in connection with insuring a standard quality of coinage. That gigantic figure in the scientific world, Sir Isaac Newton, did not think it beneath his dignity to spend many of the best years of his life developing standards for metals and processes in the British mint. However, the idea of systematically testing the common materials of every-day use is quite recent. The troubles of the early railroads with axles and rails was a great factor in encouraging such testing. The Prussian state railways back about 1850, and our own railways in "the gay 90's" began to demand materials whose strength and ductility were not merely glibly promised by the maker — or by his salesman — but were shown to exist by actual tests.

Now it is obvious that before any test, whether of strength or wear or color, can be accepted as a standard test for a material it must be shown that the test really shows the presence or the absence of the desired service qualities in the material. Some spectacular tests really tell very little about these qualities. . . . . .

Before putting much confidence in the statement that a material has been "tested" it is well to find out whether it has been tested by standard methods, methods recognized by some of the scientific bureaus of the government or by some technical society. It has come to be recognized that in devising tests and standards for materials it is vitally important that the interests of both manufacturer and consumer be considered. If the consumer alone is allowed to write specifications for a material he is likely to set up a number of fussy requirements which do not add much to the reliability of the material. but which do add greatly to the cost. On the other hand, if the manufacturer alone is allowed to write specifications he will almost certainly see to it that the materials shall be easy and profitable to produce. These statements are no reflection on the morals of either consumer or producer; they simply recognized the fact that every man naturally overemphasizes his own viewpoint. . . . . .

—From a radio address "The Romance of Engineering Materials," by H. F. Moore, research professor of engineering materials, University of Illinois.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Minimizing Heat Losses in Residences, P. E. Fansler (Architect. Forum, 51 (1929), No. 1, II, pp. 97-102, figs. 7).—Data relating to heat losses through walls, glass, roofs, and door and window leaks in dwellings are summarized, and means of reducing them are pointed out. It has been found that the heat loss through walls averages about 27 per cent of the total loss, through glass about 26 per cent, through roofs about 16 per cent, and through other openings about 31 per cent.

Data on the insulating value of different wall constructions are also presented, and testing equipment for determining air and heat flow through different types of construction is described.

Investigation of Heating Rooms with Direct Steam Radiators Equipped with Inclosures and Shields, A. C. Willard, A. P. Kratz, M. K. Fahnestock, and S. Konzo (Illinois University, Engineering Experiment Station (Urbana) Bulletin 192 (1929), pp. 69, figs. 39).—Studies conducted by the station in cooperation with the National Boiler and Radiator Manufacturers' Association and the Illinois Master Plumbers' Association are reported.

The results indicated that the use of a properly designed radiator inclosure, or shield, results in a gain in heating economy and equally or more satisfactory air temperature conditions in a room, as compared with those obtained with an uninclosed radiator. It was found that a properly designed inclosure, or shield, should offer a minimum of resistance to the flow of air over the radiator under gravity head, and should protect the wall back of the radiator against the effect of direct radiation from the radiator. It should have the top of the opening in the face of the inclosure as high as possible and should permit free access of air over the lower half of the radiator, especially near the floor.

It appears that the proper location for insulation in an exposed wall is governed by practical considerations of wall construction and the possibility of air leaks into the studding space or other air circulating channels. From the latter viewpoint it is considered advisable to place the insulation as near to the inner surface of the wall as possible.

The maximum rate of cooling for a wall exposed to a constant outdoor temperature was found to occur immediately after the heating was discontinued, and to be very high. In cases where short warming-up periods are desired after a stand-by period, with no heat supplied, it is considered advisable to install both radiation and boiler heating capacity in excess of that required to maintain a given temperature of the air at the breathing level in the rooms of a building.

Tests of Large Timber Columns and Presentation of the Forest Products Laboratory Column Formula, J. A. Newlin and J. M. Cahagan (U. S. Department of Agriculture, Technical Bulletin 167 (1930), pp. 44, pls. 4, figs. 7).—Tests conducted in cooperation with the National Lumber Manufacturers' Association are reported. The results of tests on large structural timbers, together with other test data, show that knots do not seriously affect the stiffness of timbers columns, or joists. For structural members in which stiffness rather than strength is the controlling factor, such as posts in small dwellings, it is considered entirely safe to use knotty material.

It was found that in long columns, where stiffness instead of crushing strength is the controlling factor, the loss in strength on account of knots is relatively small as compared to that for shorter specimens. The loss would be negligible in long columns of the common grade having a slenderness ratio of 30 or more to 1, and in high-grade columns with a slenderness ratio of approximately 20 to 1.

The effect of knots on the strength of short columns is proportional to the reduction in cross-sectional area that would result if all the knots in any 6 inches of the length were removed from the cross section. A column with a slenderness ratio of 11 to 1 will sustain approximately the same load as a shorter column of the same cross-sectional area.

It was found that within the elastic limit of the material the best interpretation of the behavior of long columns is the Euler formula. The decrease in cross section of an Euler column, on account of seasoning largely offsets the increase in strength which accompanies the seasoning.

The most practical expression of the behavior of intermediate columns appears to be the Forest Products Laboratory fourth-power formula. Southern yellow pine and Douglas fir columns of the type and grade tested are practically equal in strength.

A simple formula for computing accurately the strength of wooden columns used in buildings, bridges and other structures is developed, and its application demonstrated in tests on 12 by 12-inch by 24-foot timbers.

Wear Tests of Drill Shares [trans. title], Kloth (Die Technik in der Landwirtschaft, 10 (1929), No. 10, pp. 253-256, figs. 3).—Wear tests of drill shares of hard chilled gray cast iron, chilled gray cast iron, semi-steel, low test gray cast iron, and the ordinary cast iron, conducted by the Agricultural Academy of Berlin, are reported.

The hard chilled gray cast iron shares showed the least wear, and in this respect were four times as durable as the ordinary cast iron in normal sandy loam soils. The chilled gray cast iron and the semisteel shares showed slightly more wear than the hard chilled gray cast iron. Apparently the wear of these shares in sandy loam soils was nearly in inverse proportion to their hardness on the Brinell scale.

The Effect of Sulfur on the Physical Properties of Gray Iron, E. K. Smith and F. B. Riggan (American Society of Testing Materials (Philadelphia) Proceedings, 28 (1928), pt. 2, pp. 205-217, figs. 12).—Studies are reported which showed that the strength and fluidity of gray iron are not affected by sulfur, even in great excess. Brinell hardness and combined carbon are increased by sulfur, while machineability is correspondingly decreased.

Microscopic examination showed increasing sulfide areas, believed to be iron sulfide in solution in manganese sulfide, with gradual transition from normal gray iron to austenitic hard iron. There was evidence of solution of iron sulfide in iron carbide, and where the sulfur was very high of precipitation of iron-iron sulfide eutectic. Strong evidence was also obtained that sulfur can be reduced materially by the addition of manganese with the charge.

The belief is expressed that many defects attributed to sulfur have been due to other causes, and that with a proper percentage of manganese, sulfur has little effect on gray iron, at least up to 0.18 per cent.

Fruit and Vegetable Storage, L. P. McGuire (Tropical Agriculture [(St. Augustine) Trinidad], 6 (1929), No. 10, pp. 279-284).—A summary is presented of current literature dealing with the optimum storage and transport temperatures for a large number of fruits and vegetables.

The Effect of Two Types of Cast-Iron Steam Radiators on Air Temperatures in Room Heating, A. C. Willard and M. K. Fahnestock (Heating, Piping and Air Conditioning (Chicago) 2 (1930), No. 3, pp. 185-191, figs. 6).—The results of studies conducted at the University of Illinois are reported. These indicate that the steam condensation of a direct cast-iron radiator expressed in pounds of condensate is not an adequate measure of the performance of the radiator. Apparently the heating effect produced on the air in the room must be taken into consideration in making comparisons between different types of radiators.

Long, low cast-iron radiators placed under windows were found to heat a room more comfortably and more economically than higher column radiators placed at the side of the windows. Long, low cast-iron radiators maintained materially better floor to ceiling temperature differentials than high column radiators. The larger portion of the temperature differential in a room heated with direct cast-iron radiators of the column and tubular types occurs between the floor and the breathing level. The temperature used as an indication of whether or not a room is properly heated should be taken at some level nearer the floor than the breathing level.

The Kiln Drying of Southern Yellow Pine Lumber, L. V. Teesdale (U. S. Department of Agriculture, Technical Bulletin 165 (1930), pp. 67, pls. 9, figs. 9).—This bulletin presents briefly the general principles of kiln drying and illustrates the application of them to the kiln drying of southern yellow pine lumber. Specifically the purpose is to show (1) how to control drying conditions in the kiln, (2) the proper method of handling stock before and after kiln drying, and (3) the economic advantage of observance of proper kiln operation and handling methods.

Designs for Kansas Farm Homes, H. E. Wichers (Kansas Engineering Experiment Station (Manhattan) Bulletin 23 (1929), pp. 105, figs. 45).—Data are presented on farmhouse design to meet Kansas conditions. A number of plans are included.

Effect of Lumnite Cement and Plaster of Paris Caps on Strength of Concrete Test Cylinders, D. J. Tripp (Colorado Station (Fort Collins) Bulletin 349 (1929), pp. 12, figs. 7).—Experiments are reported which showed that the variation in the strength of individual cylinders is probably greater than any variation likely to occur due to method of capping. It appears that the different methods of capping do not give the same relative differences in strength when used on cylinders of various strengths. In other words, the method of capping which gives the highest strength for 1,800-pound concrete may not give the highest for 5,000-pound concrete.

Rough ends appear to have little effect on the strength when the lumnite cap is used but give a considerably lower strength when plaster of Paris caps are used. The strength shown may be only 70 per cent of the true strength in the case of high-strength cylinders. The maximum variation between the strength given by the lumnite cap and the strength shown by the standard cap is only about 5 per cent. It appears from the results obtained that strengths shown by these two caps are about the same for 3,000-pound concrete which is probably very close to the average of all of the cylinders tested. Since the standard cap is the accepted one, it appears that there can be no serious objections to the use of the lumnite cap.

An important advantage of the lumnite cap is that it has shown itself to be far easier to apply to uncapped field cylinders than any other cap tried in this laboratory. Apparently it is the strength of the cylinders and not the age which determines the effect which different methods of capping have on the strengths obtained.

Structural Engineering, G. F. Swain (New York and London: McGraw-Hill Book Co., 1927, pp. X + 525, figs. [447]).—This volume deals with the theory of statically determined frame structures, by analytical and graphical methods, and with the theory and design of masonry structures, giving the fundamental principles and the methods of their application. The theory of earth pressure is discussed also.

Design and Operation of Commercial Sweet Potato Storage Houses, M. A. R. Kelley (Virginia Truck Station (Norfolk) Bulletin 67 (1929), pp. 719-765, figs. 20).—The investigation upon which this bulletin is based was conducted cooperatively by the station and the division of agricultural engineering of the U. S. D. A. Bureau of Public Roads. It was undertaken primarily to demonstrate the possibility of maintaining fairly uniform conditions in sweet potato storage structures and to obtain data upon which to base recommendations for design and operation.

The results indicate that uniform temperatures, with reasonable control of humidity, can be maintained in sweet potato storage houses of the type tested. The moisture loss from sweet potatoes cured on a commercial scale at a temperature between 80 and 85 degrees (Fahrenheit) was found to be less than from those cured at a lower temperature. A temperature of from 38 to 40 degrees, required for the storage of locally grown white potatoes, may be maintained readily if the storage house is well insulated and properly operated. It was found difficult to hold imported northern white seed potatoes in common storage beyond the first of February at a temperature sufficiently low to insure against early sprouting.

Improvements in design and construction are recommended.

Sheathing, Nailing, Bracing to Produce Stronger Frame Buildings, F. P. Cartwright (Building Age (New York), 52 (1930), No. 2, pp. 39-41, 86, 94, 96, figs. 11).—In a contribution from the National Lumber Manufacturers' Association information is given on proper practice in sheathing, nailing, and bracing frame structures, it being shown that diagonal sheathing is about 8 times as strong as horizontal sheathing and that the twisting resistance of three nails is no greater than that of two. It is pointed out also that a 1- by 4-inch diagonal bracing let into the studs increases the strength 3.5 times and the stiffness from 2.5 to 4 times.

Effects of Moisture Changes on Building Materials, R. E. Stradling ([Gt. Brit.] Department of Science and Industrial Research (London) Building Research Bulletin 3 (1928), pp. IV + 22, pls. 4, figs. 9).—An attempt is made to summarize the principal relationships between water and materials for building construction, and to indicate what effects result from the existence of these relationships. Special attention is devoted to recent investigations on certain physical associations not generally recognized. The discussion is based upon the existence of water in building materials in chemical combination, as free water, and as absorbed water.

Physical and Mechanical Properties of Portland Cements and Concretes, W. K. Hatt and R. E. Mills (Purdue University, Engineering Experiment Station (LaFayette, Ind.) Bulletin 34 (1928), pp. 99, figs. 44).—This bulletin reports the results of investigations, conducted in cooperation with the U. S. D. A. Bureau of Public Roads, of some of the fundamental properties of concrete that underlie the behavior of this material in structures. Part 1 deals with changes of volume of cements and concretes, part 2 with fatigue of mortar and concrete, and part 3 with extensibility of concrete, considerable data being reported.

An extensive bibliography is appended.

Small Dimension Stock: Its Seasoning, Handling and Manufacture (Washington: U. S. Department of Commerce, National Committee on Wood Utilization, 1929, pp. X + 84, figs. 30).—This report of the subcommittee on small dimension stock of the National Committee on Wood Utilization, prepared by C. C. Bell, summarizes present conditions in the small dimension industry and the best practices of manufacture, seasoning and handling. A discussion is given also of cost finding and standardization.

Review of Methods of Testing Insulating and Building Materials for Heat Transmission, F. G. Hechler and A. J. Wood (American Institute of Refrigeration (Chicago) Proceedings, 17 (1928), pp. 151-179, figs. 10).—In a contribution from the Pennsylvania State College experimental methods are described for determining the amount of heat which will pass through a definite area of a material in a given time.

Pit Silos, T. P. Metcalfe and G. A. Scott, rev. by W. H. Black (U. S. Department of Agriculture, Farmers' Bulletin 825, rev. (1930), pp. II + 8, figs. 4).—This is a revision of this bulletin. Directions are given for constructing pit silos, indicating the proper size and best location.

Sewerage, A. P. Folwell (New York: John Wiley & Sons; London: Chapman & Hall, 1929, 10. ed., rewritten, pp. X—399, figs. [128]).—This is the tenth revised edition of this book. It deals with the designing, constructing, and maintaining of sewerage systems and sewage treatment plants.

Remaking a Semi-Monitor Poultry House, D. C. Kennard and V. D. Chamberlin (Ohio Station Bimonthly Bulletin 143 (1930), pp. 41-43, figs. 3).—The reconstruction of a semi-monitor type of poultry house to one with a combination type roof is briefly described.

Creosote Treatment of Douglas Fir, J. F. Harkom (Canada Department of the Interior (Ottawa) Forest Service Circular 26 (1929), pp. 12, figs. 4).—The process and equipment used are described.

Corrosiveness of Soils with Respect to Iron and Steel, H. D. Holler (Industrial and Engineering Chemistry (Washington, D. C.), 21 (1929), No. 8, pp. 750-755, figs. 5).—The results of studies conducted at the U. S. Bureau of Standards are reported in which the corrosiveness of soils as indicated by the initial losses of buried specimens in humid areas was correlated with their acidity. A relation was found to exist between the ability of a soil to react on iron with liberation of hydrogen and its total acidity as indicated by titration and the results suggest that total acidity of a soil may be an indication of its corrosive ability.

Development and Present Position of Mole Draining (International Review of Agriculture [Rome], Monthly Bulletin of Agricultural Science and Practice, 20 (1929), No. 5, pp. 192-196, figs. 10).—The present status of mole draining is briefly outlined, attention being drawn to different mole draining practices, particularly in Europe. It appears that mole draining has been attended with considerable success. The life of the channels, however, varies widely. Experiments on the lining of the drains with pipes have so far not proved very successful. A bibliography is included.

Surface Water Supply of Hudson Bay and Upper Mississippi River Basins, 1926 (U. S. Geological Survey, Water-Supply Paper 625 (1930), pp. V + 170, fig. 1).—This report, prepared in cooperation with the States of Minnesota, Wisconsin, Iowa, Illinois and Missouri, presents the results of measurement of flow made on streams in the Hudson Bay and upper Mississippi River Basins during the year ended September 30, 1926.

Studies on the Movement of Water in Soils [trans. title], M. Conti (Rev. Facult. Agron. La Plata (Argentina) 3. ser., 17 (1927), No. 3, pp. 257-275, figs. 10).—The results of comparative studies of the hydraulic properties of arable soils to provide a basis for the rational distribution of irrigation water are reported.

The studies included laboratory determinations of the velocity of vertical and lateral percolation of irrigation water in different soils, determination of the powers of absorption and retention of water, determination of the depth of penetration of irrigation water under different heads, and determination of capillarity factors under irrigation conditions.

It was found that the quantity of water absorbed by soil is proportional to its contents of humus, clay and fine sand in relation to the coefficients 3, 2 and 1, respectively. Depth of penetration was found to be nonuniform, and to vary somewhat with the fineness of the soil. The velocity of vertical penetration was more rapid in dry soils than in moist soils. The ratio of the two velocities of penetration was higher in soil rich in clay and fine material, and lower in soils rich in sand and organic matter.

Vertical penetration of irrigation water was found to be four times as rapid as lateral penetration in soil of uniform composition. Nonuniformity of soil composition caused vertical and lateral movements to become more nearly equal, especially where the humus content was high.

Surface Water Supply of Lower Mississippi River Basin, 1926 (U. S. Geological Survey, Water-Supply Paper 627 (1930), pp. IV + 98, fig. 1).—This report, prepared in cooperation with the States of Missouri, Colorado, Kansas and Texas, presents the results of measurement of flow made on streams in the lower Mississippi River Basin during the year ended September 30, 1926.

Progress Report on the Use of the Combine in South Dakota, G. Lundy, K. H. Klages, and J. F. Goss (South Dakota Station (Brookings) Bulletin 244 (1929), pp. 63, figs. 24).—This report deals with studies which were conducted partially in cooperation with the U. S. Department of Agriculture. The area around Blunt in Hughes County was selected in 1927 as a basis for the study because in this area there were a considerable number of combines in operation. During 1928 the field of work was extended to include Sully and Potter Counties. In both years data were also obtained around Brookings where a combine was operated for experimental purposes.

The number of combined harvester-threshers has increased rapidly, especially in the central and western parts of South Dakota, 648 machines being on record in 1928.

Moisture determinations made during the harvesting season of 1927 indicated a tendency for combine operators to cover too large an acreage with one machine. This attempt to harvest extremely large areas with one machine led to the practice of harvesting too early in the season, too early in the mornings while the grain was still damp with dew, or too early after rainy periods. Samples of combined wheat, barley and oats collected in 1928 showed a greater variation in moisture content than binder-harvested samples. In the case of the combined samples of wheat 43.6 per cent contained 15 per cent or a higher percentage of moisture as compared with 26.1 per cent of the binder-cut samples. On the other hand only 22 per cent of the binder-cut samples contained less than 13 per cent of moisture, while 35.8 per cent of the combined samples fell into this low moisture group. This shows that wheat of low moisture content can be obtained by the use of the combine.

The samples collected in 1928 showed very definitely that many combine users started their machines too early in the season, before the grain was sufficiently dry for harvesting. They also show a decided tendency for producers to resume harvesting operations too soon after rainy periods, before the grain is dry enough. The high moisture contents of a large percentage of the combined samples are reflected in the commercial grades of these samples. Of the samples of combined wheat 37.7 per cent graded No. 1, as compared with 48 per cent of the binder-cut samples. On the basis of experiments performed in eastern South Dakota it is not there advisable to start combining earlier in the morning than 11 o'clock except on very dry days. In some cases, as in weedy fields, it was found that grain sufficiently dry to be handled with safety could not be obtained except by delaying cutting until the middle of the afternoon. The moisture content of grains increases toward evening, but on most dry days it was found that it was safe to carry on harvesting operations until 8 p.m. As regards the time of the season to begin combining direct, farmers themselves reported that this should begin between 10 and 14 days later than the beginning of the binder harvest. On the other hand, windrowing could begin at the same time as the binder harvest, but the grain should dry in the windrow about 5 days before combining with the pick-up attachment.

The most profitable moisture condition was about 13.5 to 14 per cent. At this point the wheat had the greatest weight of moisture consistent with safe storage, and the price was best. In the case of barley and flax it was also found that the gains from drying were not as large as the spread in price between wet and dry grain. The cost of harvesting and threshing large acreages was found to be lower with the combine than with the binder or header and stationary threshers.

The results available from various investigations indicate that harvesting losses are largest with the binder, lower with the header, and lowest with the combine. But it is also shown that the combine is less efficient as a thresher than the stationary separator. However, taken as a whole the losses with the combine were found to be only about 0.6 or 0.7 as great as with the binder and separator.

Data are presented also on market discounts for combined wheat, the relative costs of harvesting by combine and other methods, and on artificial drying. A list of publications on combining is included.

Contributions to the Hydrology of the United States, 1928 (U. S. Geological Survey, Water-Supply Paper 597 (1929), pp. V + 250, pls. 23, figs. 20).—Six papers are included as follows: Geology of Reservoir and Dam Sites (pp. 1-38) and Geology of the Owyhee Irrigation Project, Oregon (pp. 39-72), both by K. Bryan; A Study of Ground Water in the Pomperaug Basin, Connecticut, with Special Reference to Intake and Discharge, by O. E. Meinzer and N. D. Stearns (pp. 73-146); Problems of the Soft-Water Supply of the Dakota Sandstone, with Special Reference to the Conditions at Canton, South Dakota, by O. E. Meinzer (pp. 147-170); Geology and Water Resources of the Upper McKenzie Valley, Oregon, by H. T. Stearns (pp. 171-188): and Surface Water Supply of the Sacramento River Basin, California, 1895-1927, by H. D. McGlashan (pp. 189-243).

Daily River Stages at River Gage Stations on the Principal Rivers of the United States, H. C. Frankenfield (U. S. Department of Agriculture, Weather Bureau, Daily River Stages, 26 (1928), pp. II + 290).—This is the twenty-sixth of a series of daily river stages on the principal rivers of the United States, and presents data for 1928.

The Submerged Weir as a Measuring Device, G. N. Cox (Wisconsin University Engineering Experiment Station (Madison) Bulletin 67 (1928), pp. 153, figs. 41).—Studies made of submerged weirs are recorded. Results indicate that the flow over sharp crested submerged weirs is dependent upon the three halves power of the upstream head, and upon the ratio of the downstream head to the upstream. This is expressed by the formula $Q = CLH^{1.5}$, where $C = 4.3\ [1-(S \div 0.002)]^{0.25} - 0.822$. In this formula the Q is the discharge in cubic feet per second, C is the coefficient of discharge, L is the length of the weir in feet, H is the upstream head on the weir in feet, and S is the per cent submergence. This formula is applicable only when the nappe flows above and does not plunge under the surface.

It was found also that the sharp crested weir does not operate in a satisfactory manner when the nappe plunges under the surface, and it is recommended that it be not used under such conditions. The height of the weir does not affect it but does affect the position at which the downstream head is measured. The distance downstream to the low point is directly proportioned to the height. A correction for the velocity of approach must be made and added to the upstream head before the per cent submergence or discharge is computed.

It was found that the flow over Ogee submerged weirs can not be obtained from as simple a formula as the sharp crested weirs. The exponent varies for different percentages of submergence. The range of flow with the nappe under is the most stable, and the discharge is independent of the height of the weir for this type of flow. The discharge is not independent of the height of the weir when the nappe is flowing on the surface, more water discharging for similar conditions over the higher weirs. The conditions of flow are not as stable, nor the formulas as satisfactory for the type of flow of nappe over, and the use of the Ogee submerged weir is not recommended for this type of flow. The distance from the weir to the position for measuring the downstream head is directly proportional to the height of the weir. A velocity of approach correction must be made and added to the upstream head before the per cent submergence or the discharge is computed.

It is concluded that in general the water in the channel above the weir should move with a uniform velocity. Baffles should be used for accomplishing this, and, if space is available, should be placed 30 or 40 feet upstream from the weir. The channel walls should be vertical and parallel to each other. The channel should continue with uniform section downstream from the weir for a minimum distance of five times the height of the weir. It is felt that for a range of heads between 0.2 and 2.5 feet, the submerged weir will operate and give results within 5 per cent by the use of the recommended formulas, provided the above recommendations concerning arrangement have been followed.

The Flow of Water in Riveted Steel and Analogous Pipes, F. C. Scobey (U. S. Department of Agriculture, Technical Bulletin 150 (1930), pp. 136, pls. 6, figs. 10).—This bulletin brings together a large amount of engineering data from various sources on the carrying capacity of pipes made of steel and plate steel or iron as used in general service for the conveyance of water under pressure. Special attention is devoted to the results of field experiments by the author, made for the primary purpose of determining the proper capacity of pipes for the conveyance of water for irrigation use, it being pointed out that the laws thus developed apply equally well if the water is to be conveyed for power domestic, or other use.

Two appendixes contain abstracts of reports of experiments by others on the subject, and an extensive bibliography is included.

The thoroughness of the analysis of the available data is indicated by the characteristically pointed conclusions of the author. These indicate that there is a material difference in the carrying capacities of steel pipes. Other things being equal, the difference is due to the type of unit assembly and the field joints. Present indications, based on the performance of pipes of various ages, are that all iron and steel pipes lose capacity progressively when in use. The general term "riveted pipe" is insufficiently distinguishing for use in capacity specifications. Plate thickness, type and size of rivets, and method of making joints all have noticeable influence on capacity.

Book Review

"Douglas Fir Use Book" is an architects and engineers handbook containing design tables and supporting technical data which will simplify the design routine of figuring loads and specifying sizes wherever Douglas fir is concerned. It is published by the West Coast Lumbermen's Association and supersedes the "Structural Timber Handbook on Pacific Coast Woods," published by the Association in 1916. The volume embodies and follows the latest information and standard practice on grades, sizes, and stresses. It may be obtained from the Association (364 Stuart Building, Seattle, Washington) at $1.00 per copy.

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

RAYMOND OLNEY, Editor

R. A. Palmer, Assistant Editor

Farm Management

A VOTE taken at the farm management session of the ASAE Power and Machinery Division meeting in Chicago in December showed that a majority of those present favored the organization, in the Society, of a definite and permanent farm management group.

The program of the day had dramatized and emphasized the fact that there is necessarily a close relationship between agricultural engineering and farm management. Hence the vote. It had done little to analyze and clarify that relationship. As a result no definite proposal could be offered to the Society, and farm managers present were left wondering whether they should be members of a professional farm managers organization of the American Society of Agricultural Engineers, or of both.

It is only natural that someone suggested the possibility of one profession stepping on the toes of another, if both should undertake to work in the same field. This is possible, but it can easily be avoided. The work will divide itself naturally, if the functions and professional opportunities involved are analyzed impartially. The apparent overlapping of agricultural engineering and farm management is subject to such analysis.

As a premise, let us say that farm management is the work of controlling and directing biologic production by physical means for economic and social purposes. By that definition it is a broad profession requiring a high degree of versatility.

It is broader than the knowledge of biologic science which shows how two blades of grass can be made to grow where one grew before; broader than its agricultural engineering phases, the provision and application of the physical means of economically controlling and directing biologic production; broader than the economic background which has fostered it and which is still its administrative parent in the land grant institutions; broader than its labor and other human problems.

Farm management is a practice. Biology, agricultural engineering, economics, psychology and sociology furnish its supporting technology.

Farm managers, therefore, need their professional organization to look out for their broad professional interests. In his paper on the farm management program Frank Reinoehl cited some of the functions and opportunities of their organization as follows: "I have observed with approval that the American Society of Farm Managers has organized for the purpose of standardizing certain practices in farm management. It is to be hoped further that this organization will also set up certain standards of qualifications for men in this profession and thus give it a real professional status."[1]

But the ultimate success of management depends upon technological as well as professional progress. The Management Division of the American Society of Mechanical Engineers supports this viewpoint in these words: "It is becoming increasingly evident that industrial management must grow along scientific lines rather than by development through the sheer force of circumstances."[2]

The same applies to management in agriculture. It is almost self-evident that a farm manager cannot be his own technological assistant. He cannot undertake extensive research programs. He cannot economically hire specialists to create technologic progress to his individual order. He must rely on getting groups of specialists interested in his technological problems. Even in that he has to compete with other groups and individuals who are appealing to the same specialists to work on other problems.

Therein lies the occasion and opportunity for a definite and permanent farm management group in the American Society of Agricultural Engineers. It would provide a continuous, effective contact with agricultural engineers within their own organization; it would enable the farm managers to take the initiative in presenting to agricultural engineers their viewpoint, engineering problems, and working conditions; it would keep agricultural engineers interested in studying and making progress in the engineering technology of farm management; it would help coordinate progress in the engineering side of farm management with its biologic, economic and other phases.

Included in the group would be not only the farm managers but all the agricultural engineers interested in the farm managers' power and machinery, structures, reclamation, electrification and other engineering problems. Agricultural engineering for farm management, rather than for its own sake or the good of any other interests, would be the guiding principle in its activities.

A group of this type and purpose would in no way meet or overlap the functions of the farm managers' professional organization. It would advance rather than conflict with the best interests of that organization. The relationship between the two would be analogous to the relationship between the Management Division of the American Society of Mechanical Engineers and the American Management Association.

The extent to which farm managers are ready and willing to do their part in developing the engineering technology of their work is another question. Undoubtedly it would be inadvisable to organize a farm management division in the American Society of Agricultural Engineers immediately on the strength of the informal vote taken at Chicago. The need of giving farm management some organized and consistent consideration in the Society is becoming increasingly apparent, however. In view of the situation it would be a constructive step on the part of the Society to respond to the farm managers' vote in Chicago with the organization of a standing general committee on farm management. That committee could study the matter further, make recommendations as to ASAE policy on farm management activities and sponsor any additional activities and organization along that line that might seem desirable.

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[1] "The Farm Manager and His Responsibility to the Profession," by Frank W. Reinoehl, chief farm manager, Colonization Finance Corporation of Canada, Ltd. To be published in an early issue.

[2] "Progress in Industrial Management," "Mechanical Engineering," Vol. 53, No. 1 (January 1931).

New Standards Projects

FOR more than a year the American Society of Agricultural Engineers has had in progress the development of standards for disk blades and the power take-off. The approaching completion of these projects will (1) demonstrate the inherent advantage and capacity of the Society as a standardizing body in its field and (2) leave it without an active standardization project unless one is started soon.

In other words, now is an opportune time to initiate in the Society one or two new standardization activities. Standardization work in the Society is started as a result of one or more men seeing the need of standards on some particular item or subject, studying the need and possibilities from all angles, and offering some definite suggestion as to how a project might be organized and carried to completion.

Surely there is a potential demand for some further standardization in agricultural engineering materials, equipment, methods or terminology. Bring on your suggestions. Let's keep the standardization pot boiling.

World Competition in Agriculture

AMERICAN agriculture has not only produced an exportable surplus of a few of its leading commodities, but is on the verge of doing that with others, according to Dr. W. J. Spillman in his paper published in this issue.

This is no tragedy, as some people are believing it, but a sign of progress. It is the natural result of increasing application of biologic, engineering and other sciences to the agriculture of this country.

It is a point at which our prices of farm products drop sharply to the level of the world market and at which our farm production costs must be lowered correspondingly to enable our farmers, without lowering their standard of living, to compete with the peasant farmers of some other countries.

As Dr. Spillman points out, this implies a thorough reorganization of our agriculture. It means putting agriculture on an efficiency basis; making extensive and intensive use of labor-saving methods and equipment; taking advantage, to a greater extent than ever before, of available scientific knowledge of agriculture; recognizing more fully than before the advantages of each farm or locality for producing certain commodities and its unsuitability for the efficient production of other commodities, and being guided accordingly. It means taking some lands out of agricultural production and putting other lands into production. It means more careful planning and execution in the utilization of farm land, capital, labor, products and by-products.

The bridges are all burned behind the march of economic progress. There can be no turning back. There is nothing to do but reorganize agriculture and go ahead; or to give up our position as an agriculturally important and independent nation. Our position in this respect is ably pictured by Wheeler McMillen[1] in the following paragraphs:

> "The attitude that says we should abandon our position in world markets in favor of foreign competitors is not only inconsistent with the genius of America, but is fraught with danger. Let it be remembered that agriculture represents today a political minority. We can not always lean on the tariff wall. The consumer majority will demolish that barrier if provoked. If we now abandon the effort to hold our place in the world markets, we shall be taking the first steps toward the loss of our domestic market. Should we withdraw within the wall and should the wall collapse, we might find ourselves out of some business at home. The only safe course is rigorous pursuit of ever increasing efficiency.
>
> "American agricultural science, engineering and management certainly will not set a precedent of admitting defeat. In every single case where an American product dominates the world market, the explanation may be found in our lower cost of production. The industries where we cannot hold our places in the world market are those in which some hand operation limits the output per worker, and which reduces that worker to parity with underpaid producers of other countries."

[1]Associate editor, "The Country Home." Mr. McMillen gave the paragraphs quoted in an address before a recent meeting of the American Railway Development Association.

Farm Building Economics

J. L. STRAHAN in his paper on "The Economics of Farm Structures" (page 6) strikes another effective blow in his consistent attempt to drive home the fact that a lack of economic data is the limiting factor in progress on the farm structures side of applying engineering to agriculture.

As he points out, getting the necessary data is a big job. The return on the investment which a farm building may yield, by reason of the value of its shelter to certain machines, materials and processes of a farm production program, is influenced by a large number of variables. Its annual shelter value must be the sum of its shelter values to the units sheltered during the year. Its net annual return must be this sum minus the value consumed in various incidental and fixed costs.

We can express these relationships in the form of a simple equation, but when we do so and try to solve for net annual return by writing in numerical values for each of the factors, we are stuck. Some of these important values are still unknown quantities. We even lack data which might enable us to closely approximate the actual figures.

For example, from what destructive influences does a tractor, a bushel of wheat or the process of milk production need to be sheltered? How prevalent are these destructive influences in different localities? What is the measure of their probability, variability and intensity? What would be the effect on the value of a tractor or bushel of wheat or on the productivity of a dairy cow of leaving it exposed to varying degrees of intensity of one or more destructive influences for varying lengths of time? What effect would varying kinds and degrees of shelter for varying periods of time have on the value or productivity of the sheltered unit? Add to the above variables for a building as a whole and for its various parts the range of incidental and fixed costs of providing varying kinds and degrees of shelter by means of available materials, designs and construction methods. Figure in the probability of changes in the demand for and price of farm products; in farm production methods; in the nature and value of the machines, materials and processes to be sheltered. Take into account the number and variety of items to be sheltered and their widely differing shelter requirements. Consider also the fact that the financing back of the production program and the opportunities for improving its efficiency in other ways influence the amount which can economically be invested in the farm buildings of a particular farm. This will give some indication of the complexity of the problem.

It is evident from the lack of specific data on many of the above points that agricultural engineering work in farm structures lacks a scientific as well as an economic basis for progress.

The prospect of acquiring the necessary data on the individual and interrelated influences of such a large number of factors with the wide range of variability indicated may appear hopeless. But it is not. It must be done as a basis for effective extension work in farm buildings and for further architectural and structural engineering progress in this field. It can and will be done. A start has been made by such men as Strahan, by White and Wooley, whose work he cites, by Giese and others, even though it may be with a somewhat different viewpoint of the problem and from different angles of approach. More power to them.

A. S. A. E. and Related Activities

Statement on Reclamation Drafted at Frisco Meeting

TO HELP spread the life-giving water of facts over the drouth-stricken area of current public opinion on land reclamation, the Land Reclamation Division of the American Society of Agricultural Engineers at its joint meeting with the Pacific Coast Section, in San Francisco, January 6 and 7, drafted a statement emphasizing the long-time nature of reclamation projects.

Papers and addresses on the program were delivered substantially as scheduled and were of high caliber. The Pacific Coast Section at its annual business meeting, sandwiched in during the noon hour on January 7, elected officers and heard a report of its secretary.

Major O. V. P. Stout, irrigation engineer of the U.S.D.A. and an honorary member of A.S.A.E., was elected chairman of the Pacific Coast Section for 1931. The report of the nominating committee was accepted with the casting of a unanimous ballot for its whole ticket. It gives Chairman Stout the assistance in the capacity of vice-chairmen, of Osgood Murdock, editor of "Implement Record"; Hobart Beresford, head of the department of agricultural engineering, University of Idaho; and M. R. Lewis, irrigation engineer, Oregon State College. Walter W. Weir, of the division of soil technology, University of California, was reelected secretary-treasurer of the Section and O. W. Sjogren, agricultural engineer, Killefer Manufacturing Corporation, became the elective member of the executive committee.

Following the secretary's report there was some discussion of the Section's finances and also of the advisability of the Section inviting the A.S.A.E. to hold its annual meeting in 1934 somewhere in California.

Land reclamation activities require consistant administration over a long period of time with a view to the economic outlook for the future rather than for the current situation at any given time, according to the statement drawn up and tabled for further consideration by the Land Reclamation Division. The complete text follows:

> The reclamation of lands for agricultural production has been and will continue to be a vital factor contributing to national wealth and stability. The urge for such development is chiefly economic, thus receiving greatest public support during periods of greatest national prosperity. This public tendency contributes to urgent and often hasty preliminary studies of tentative projects which may later lead to unwise development, resulting in subsequent embarrassment to the projects in meeting their financial obligations.
>
> The Land Reclamation Division of the American Society of Agricultural Engineers believes in the soundness of federal support and suprevisory development of agricultural areas by reclamation where these are economically feasible. We desire, however, to direct attention the necessary lapse of time which occurs between the inception of a project and the time it comes into maximum fruition. This period may be as long as twenty-five years.
>
> Accordingly we urge that the federal government maintain and adequately support the proper agencies to make and develop long-time engineering and economic studies of probable reclamation projects in order that such projects as may be approved will be undertaken at times when their period of development may fit into national economic progress.
>
> The Land Reclamation Division wishes to commend the federal and state governments for their splendid services to reclamation development and we pledge our support to these agencies in carrying out the responsibilities outlined in this statement.

Conference for California Implement Men

A "CONFERENCE in Agricultural Engineering," for implement manufacturers, dealers, and service men was held at the College of Agriculture, University of California, December 4 and 5, under the direction of the division of agricultural engineering. The California Retail Hardware and Implement Association and the Tractor and Implement Club requested the conference and cooperated in making it possible. The conference this year was held as a result of the success of a similar affair tried for the first time last year. It promises to become an annual event.

The purpose of the conference this year was to discuss the principles underlying the operation and application of tillage and harvesting equipment, giving special attention to row-crop tools. H. B. Walker and Roy Bainer of the division of agricultural engineering arranged the program. ASAE. members on the program were Roy Bainer, E. N. Bates, J. P. Fairbank, B. D. Moses, Osgood Murdock, W. L. Paul, O. W. Sjogren, and H. B. Walker.

Bureau in Appropriation Bill

A "BUREAU OF AGRICULTURAL ENGINEERING" is provided for in the agricultural appropriation bill for the fiscal year 1932, H. R. 15256, as passed by the House of Representatives on December 19. This is further than it has ever before gone in running the gauntlet of U. S. Treasury guardians and it may reasonably be expected to be passed by the Senate and approved by the President.

Provision of a Bureau at this time would mark the successful completion of twelve years of organized effort on the part of agricultural engineers to secure for agriculture the benefits which must arise from increased official recognition and support of research and extension work in the field of agricultural engineering. The American Society of Agricultural Engineers first directed its efforts toward this end in 1919.

This item in the bill is worded as follows:

> BUREAU OF AGRICULTURAL ENGINEERING
>
> Salaries and Expenses
>
> For necessary expenses for general administrative purposes, including the salary of chief of bureau and other personal services in the District of Columbia, $30,000.
>
> For investigations, experiments and demonstrations involving the application of engineering principles to agriculture, independently or in cooperation with federal, state, county or other public agencies or with farm bureaus, organizations or individuals, for investigating and reporting upon the utilization of water in farm irrigation and the best methods to apply in practice, the different kinds of power and appliances, the flow of water in ditches, pipes and other conduits, the duty, apportionment and measurement of irrigation water, the customs, regulations and laws affecting irrigation, and the drainage of farms and of swamps and other wet lands which may be made available for agricultural purposes; for preparing plans for the removal of surplus water by drainage; for developing equipment for farm irrigation and drainage; for investigating and reporting upon farm domestic water supply and drainage disposal, upon the design and construction of farm buildings and their appurtenances and of buildings for processing and storing farm products, upon farm power and mechanical farm equipment, upon the engineering problems relating to the processing, transportation and storage of perishable and other agricultural products, and upon the engineering problems involved in adapting physical characteristics of farm land to the use of modern farm machinery; for investigations of cotton ginning under the Act approved April 19, 1930 (46 Stat., p. 248); for giving expert advice and assistance in agricultural engineering; for collating, reporting and illustrating the results of investigations and preparing, publishing, and distributing bulletins, plans, and reports; and for other necessary expenses, including travel, rent, repairs and not to exceed $5,000 for the construction of buildings, $553,840.
>
> Total, Bureau of Agricultural Engineering, $583,840, of which amount not to exceed $139,230 may be expended for personal services in the District of Columbia.

Bringing to the farm *the efficiency of the factory*

Here are three fundamental facts about lubrication of industrial machinery. They are equally true of farm machinery.

1 Correct lubrication . . . Alemite Specialized Lubrication . . . will reduce machinery repair bills 80%.

2 Correct lubrication . . . Alemite Specialized Lubrication . . . will save 70% of the time required for lubricating.

3 Correct lubrication . . . Alemite Specialized Lubrication . . . will reduce the cost of lubricant 50%.

Consider, in the light of these facts, how Farmers can reduce overhead expense and increase production efficiency by buying only Alemite equipped machinery, by installing the Alemite System on the machines they now own, by using only Genuine Alemite Lubricants.

Alemite Specialized Lubrication comprises first the Alemite High Pressure System and Alemite Compressors. Second, Alemite Special Lubricants, manufactured under strict and scientific formulas so as to give 100% efficiency to the Alemite System.

ALEMITE
The farmer brings his handy filler tank for new supply.
The drum of Alemite Lubricant, equipped with a special pump, remains in the dealer's store.
Or, he does the same with this filler bucket.
From the filler tank or bucket he fills his Alemite gun.
Each bearing receives its shot of clean, Alemite Lubricant, in 2 seconds.

Today, over 100 manufacturers of farm machinery have adopted The Alemite System as standard equipment for their machines.

For machinery not equipped with Alemite System, the farmer can, by going to his farm implement dealer, buy the fittings and very easily equip his machinery with them.

It is generally conceded among authorities on the farm question that the farmer's salvation lies largely within his own organization. In other words, ways and means must be determined which will help do his present job better.

Alemite helps him do that. Alemite brings to the farm the efficiency of the factory.

We have prepared for students of farm and agriculture, efficiency material well worth studying . . . material you will want to keep on file for constant reference. A line from you will bring it.

ALEMITE

ALEMITE CORPORATION (Division of Stewart-Warner) 2656 North Crawford Avenue, Chicago

American Standards Association

THE association announces the formation of two technical groups of its sectional committee on small tools and machine tool elements to formulate standards for splines and splined shafts, one group to undertake the development of spline standards for the machine tool industry and the other for the automotive and aeronautical industries. The committees will act independently of each other, although the recommendations of both will be submitted for approval of the general committee.

Previous attempts to standardize splines have been restricted to the fitting or soft broached hole, certain factors in all spline applications having been considered too variable to permit similar standardization in the mating part, or shaft. Recently a reversal of this opinion has been observed through the standards on the subject developed by the General Motors Corporation and the British Engineering Standards Association, both of which establish definite dimensional limits for both the fitting and the shaft. The committee plans to follow this latter precedent so as to permit greater freedom in the development of the standards and, further, will disregard for the present the existence of patents which might be thought to affect methods of spline manufacture.

A proposed American standard for machine pins of the cylindrical and taper types has been prepared by a technical committee of the Association and is now being circulated for review and criticism. Copies of the proposal may be secured for this purpose from the Association (29 West 39th Street, New York, N. Y.). The draft proposal covers a diameter range of taper pins from 1/16 to 1½ and a length range of ½ to 12 inches.

Personals of ASAE Members

Roy Bainer, assistant professor of agricultural engineering and assistant agricultural engineer in the experiment station, and **J. D. Long,** junior agricultural engineer in the experiment station, University of California, are joint authors of California Agricultural Extension Service Circular 47, entitled "Equipment for the Bulk Handling of Grain."

J. W. Carpenter, Jr., is now located at Stillwater, Oklahoma, where he has charge of the agricultural engineering extension work at the Oklahoma A. & M. College. Mr. Carpenter formerly was agricultural engineer of the Mississippi Agricultural Experiment Station.

B. P. Hess recently joined the general sales department of the Westinghouse Electric & Manufacturing Company, at East Pittsburgh, Penn., in which capacity he will give special attention to rural electrification work. He recently secured his bachelor's degree in electrical engineering at Ohio State University and is now ranked as both an agricultural engineer and electrical engineer.

O. E. Hughes, extension agricultural engineer, University of Georgia, is author of Georgia State College of Agriculture Bulletin 394, (December, 1930) entitled "Terracing Farm Land in Georgia."

George W. Iverson has joined the J. I. Case Company, Racine, Wisconsin, as sales manager in charge of the industrial division. His previous position was that of assistant sales manager of the Caterpillar Tractor Company.

Frank J. Zink was recently appointed associate professor of agricultural engineering, Kansas State Agricultural College, in charge of power and machinery work. Up to the time of this appointment he was agricultural-electrical engineer of the Westinghouse Electric & Manufacturing Company.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Henry J. Barre, teaching fellow, Iowa State College, Ames, Ia.

William Harrigan, supervisor, manufacturers service, The Texas Company, New York, N. Y.

Thomas N. Jones, fellow in agricultural engineering, Alabama Polytechnic Institute, Auburn, Ala.

Arthur B. Kennerly, farm manager, Cartwright Ranch, Dinero, Tex.

Kirk M. Reid, illuminating engineer, General Electric Company, Cleveland, O.

George Valentine, vice-president, Massey-Harris Company, Ltd., Toronto, Ontario, Canada.

Every Voros, assistant professor, Royal Hungarian, Joseph Technical University, Budapest, Hungary.

Robert A. Work, assistant irrigation engineer, U. S. Department of agriculture, Medford, Ore.

Transfer of Grades

Harry Hummel, farmer manager, E. C. Smith Dixboro Farms, Ann Arbor, Mich. (Junior to Associate Member.)

Harold D. Lewis, associate in agricultural engineering, University Farm, Davis, Calif. (Associate Member to Member.)

Russel L. Perry, assistant professor, University Farm, Davis, Calif. (Junior to Associate Member.)

New ASAE Members

Curtiss L. Cook, assistant designer, Syracuse Chilled Plow Co., Syracuse, N. Y.

Elgin C. Davis, U. S. Commissioner on land appraisement, East Prairie, Mo.

N. L. Simmons, vice-president, Kraft Phenix Dairies, Inc., Wausau, Wis.

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is on charge for this service.

Men Available

AGRICULTURAL ENGINEER, degree from Ohio 1924. Associate member of American Society of Agricultural Engineers, one year with barn equipment company as draftsman and salesman, three years drainage specialist in middle western states, two and one-half years county agricultural agent, experienced in handling power machinery and equipment, organizing and handling labor, two years mechanic in United States army, desires permanent employment as extension engineer, position with a farm machinery company or agricultural enterprise. Willing to go anywhere; 33 years old, married, two children. MA-187.

AGRICULTURAL ENGINEER now serving as assistant professor of agricultural engineering in a state agricultural college desires to make a change this spring. Twelve years experience, has fundamental training in both mechanical engineering and horticulture as well as graduate study in Smith-Hughes teacher training, and has taught all phases of agricultural engineering, assisted in building up a research program and organizing a department of agricultural engineering. Age 38. Married. MA-190.

AGRICULTURAL ENGINEER, 1926 graduate, desires connection either in research work or in sale of farm machinery or electric utilities in the East. Has had experience in teaching water systems, farm power machinery, household electricity, and tractors, including extension work in these subjects. Has also done research work on oils, paints and farm machinery. Married. MA-191.

AGRICULTURAL ENGINEER, bachelor's degree in agricultural engineering from Iowa State College 1927, six years farm experience, six months extension experience, three and one-half years with utility in rural electrification sales work. Two and one-half years as salesman and one year in supervisory work. Desires connection with utility field or with electrical equipment manufacturer where sales promotion experience can be used. Age 29, in good health, married, with one child. Location immaterial. MA-192.